Devoted to
TEXTILE
CHEMISTRY
BLEACHING
DYEING
PRINTING
FINISHING

AMERICAN DYESTUFF REPORTER

JUNE 16, 1947
VOLUME 36, No. 12

JUN 23
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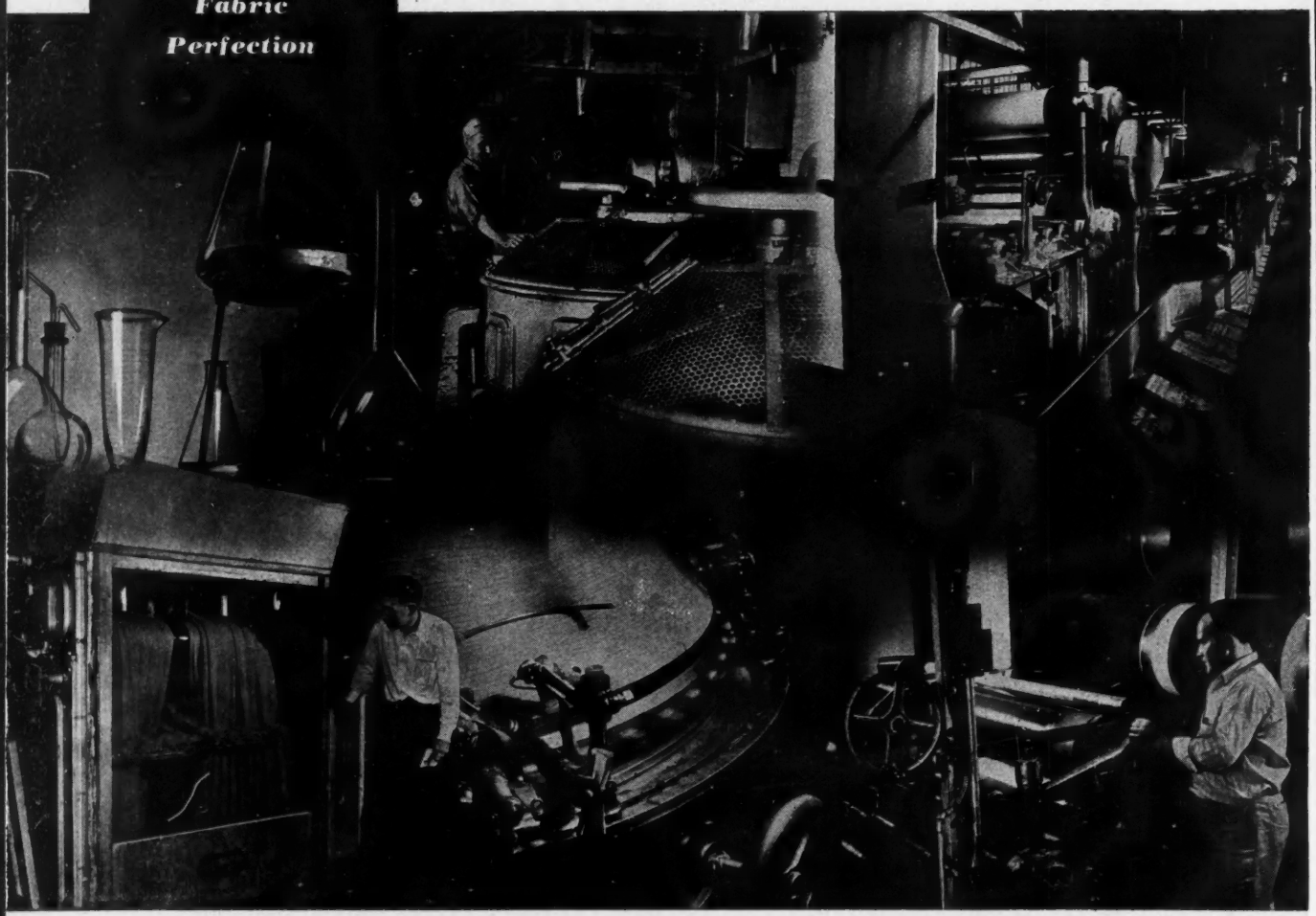
Chromacyl*
ORANGE R
For application to wool, worsted piece goods, and yarns . . . either in self shades or in combination . . . for suitings, bathing suits, sportswear, heavy outer garments, and carpet yarns.
"CHROMACYL" Orange R has very good fastness to light and dry cleaning . . . good resistance to washing, perspiration, and pressing. Level dyeing . . . has good solubility and penetrates satisfactorily. E. I. du Pont de Nemours & Co. (Inc.), Dyestuffs Division, Wilmington 98, Delaware.
*Reg. U. S. Pat. Off.
Du Pont Dyestuffs
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY
DUPONT

OFFICIAL PUBLICATION
of the
PROCEEDINGS
AMERICAN ASSOCIATION
OF TEXTILE CHEMISTS
AND COLORISTS

CHEMICAL RESEARCH *for* *Fabric Perfection*



*Reg. U. S. Pat. Off.

SULFANOLE*

Sulfanole, a result of Warwick research, is a synthetic detergent that has brought about a fundamental change in the soaping, dyeing and wet finishing processes for all textile fibres and fabrics. Sulfanole embodies all the advantages of soap, increased to a higher value, without any of its disadvantages. Each of the many Sulfanole products has its individual use, will overcome specific plant problems. A Warwick technical advisor is always available to help you work out a formula for your individual needs.

WARWICK CHEMICAL COMPANY

A Division of Sun Chemical Corporation

580 FIFTH AVENUE, NEW YORK 19, N. Y.

U. S. Pat. Off.

LEVELENE

the new 4-way dye house assistant

AMERICAN ANILINE PRODUCTS, INC.

50 UNION SQUARE, NEW YORK, N. Y., Plant: Lock Haven, Pa. *Branches:* **Providence, R. I. • Philadelphia, Pa. • Chattanooga, Tenn. Boston, Mass. • Charlotte, N. C. • Chicago, Ill. • Los Angeles, Cal. • Dominion Anilines & Chemicals Ltd. • Toronto, Canada • Montreal, Canada**

American Dyestuff Reporter, Vol. 36, No. 12, June 16, 1947. Published every other Monday. Copyright, 1947, by Howes Publishing Co., One Madison Ave., New York 10, N. Y. Domestic subscription, $5.00; Canadian, $6.00; Foreign $6.00. Entered as second-class matter, Nov. 6, 1919, at the New York, N. Y., Post Office, under the act of March 3, 1879.

Snag Resistance at the Pairing Table

What do body and snag resistance mean to the girl who pairs stockings? They mean easier handling, freedom from worrisome pulls, increased production. This means increased profits to you. Filaseal Resin Finishes impart added body and increased snag resistance to stockings without the use of special equipment. Can be applied in the finishing bath after the dye has been dropped.

Filaseal gives stockings *memory* . . . that extra quality that causes stockings to return to their original shape even after handling or creasing. *Memory* brings stockings to the hosiery counter fresh and smooth, they look better — sell faster.

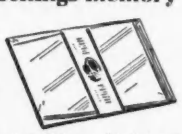
Learn today how to increase your production, reduce the number of seconds. Give your stockings *memory* with Filaseal Resin Finishes.

AMALGAMATED CHEMICAL CORP.
Philadelphia 34, Penna. : : Southern Representative
Robert A. Bruce, P. O. Box 35, Greensboro, N. C.

Filaseal

— to give your stockings *memory*

Stockings that look "handled" stay on the hosiery counter until all the "fresh" stockings are sold.



Stockings finished with Filaseal sell faster...stay smooth and fresh . . . resist snags and pulls.

Flotex FOR FAST BLACK PRINTING

for dramatic contrast

FLOTEX yields prints that are blacker and sharper in detail than those obtained with natural gum thickeners. It produces a high viscosity with low solids . . . deposits only a thin film on the cloth . . . washes out completely . . . and leaves the printed portion of even the sheerest of fabrics soft and pliable.

FLOTEX is a colorless, clear-cooking thickener that serves as a replacement for relatively more expensive Tragacanth, Locust Bean and other natural and synthetic gums for either roller machine or screen color printing.

FLOTEX — because of its long-flowing, non-jelling properties — is especially suitable for use with Aniline, Diphenyl and Logwood Blacks. Its ability to remain stable in the presence of acids and alkalies makes it especially suitable for printing Rapidogen or Pharmasol, Indigosol or Algosol and Napthol colors — on all types of fabrics.

National also produces: **CLEARFLO** for sheer, lustrous finishes; **AMBERTEX** a heavy-bodied thickener for white discharge and vat color printing; **VAT THICKENER 36** for vat colors on cotton and rayon; **TABLE ADHESIVE** for screen printing; **FLOCK ADHESIVE 970** for chenille flock printing.

Offices: 270 Madison Avenue, New York 16; Boston, Philadelphia, Atlanta, New Orleans, Indianapolis, Chicago, San Francisco and other principal cities. In Canada: Meredith, Simmons & Co., Ltd., Toronto and Montreal. In Holland: Nationale Zetmeelindustrie, N. V., Veendam.

Photo Courtesy of
COTTON-TEXTILE INSTITUTE

National
STARCH PRODUCTS

STARCHES—AND SPECIALTIES WITH EASILY DEMONSTRATED SUPERIORITY

SMITH-DRUM...

....OFFERS THE ONLY

SPECIFICALLY DESIGNED TO HANDLE YA

Here, FOR THE FIRST TIME, is a completely integrated system especially designed for preparing, dyeing, extracting and drying yarn in package form. Each machine is the result of extensive research and experimentation to develop the best design for the specific purpose of handling packages . . . to eliminate the disadvantages of other types of machines and to provide many new advantages. This system results in faster, more uniform work . . . cuts costs . . . reduces labor.

FORMULATING . . . This machine dyes a single package and is designed for laboratory use in determining the approximate formula to be used in the larger batch machine. It provides more accurate control of the formula, because the sample is dyed under exactly the same conditions as the complete batch.

FORMING . . . This machine properly prepares the package for dyeing by crimping the edges of the package to aid penetration of the dye liquor at that point.

DYEING . . . This machine, introduced by Smith-Drum several years ago, has completely revolutionized package dyeing. An entirely new

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completely
entirely new

Complete System

YARN IN PACKAGE FORM

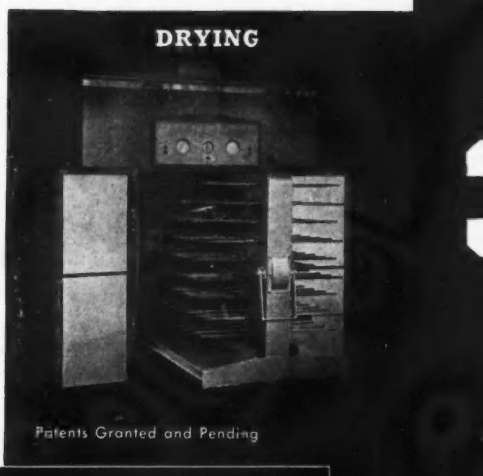
type of package carrier and a radical departure in spindle design reduce resistance to flow, providing much greater flow of liquor through each package than the conventional types of machines. This greatly increases the speed of dyeing and improves uniformity of results.

EXTRACTING . . . This brand-new Smith-Drum machine extracts packages in 70 seconds running time. The degree of extraction is equal to a high-speed 48" conventional extractor. This means a big saving in both steam and electricity in the drying process. It also reduces labor costs by simplifying loading and unloading so that even a girl can operate it. Complete cycle, including loading and unloading, is only 2 minutes. The machine also reshapes the package and prevents crushing of dye tubes.

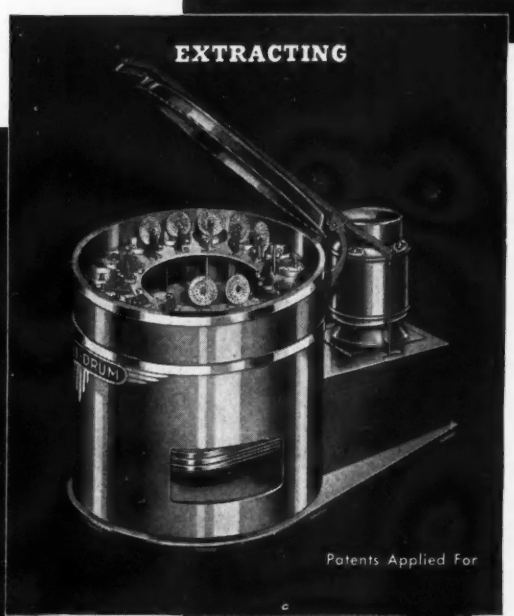
DRYING . . . Another new Smith-Drum development, employing a new principle in package drying. Cuts drying time as much as 75%. Production is approximately 300 to 350 packages per hour. It uses less electricity . . . prevents migration of color . . . eliminates salt deposits. Yarn is delivered in better condition because of short drying cycle. Drying is more uniform than by other methods.

Complete information on any or all of these machines will be sent to you promptly upon request.

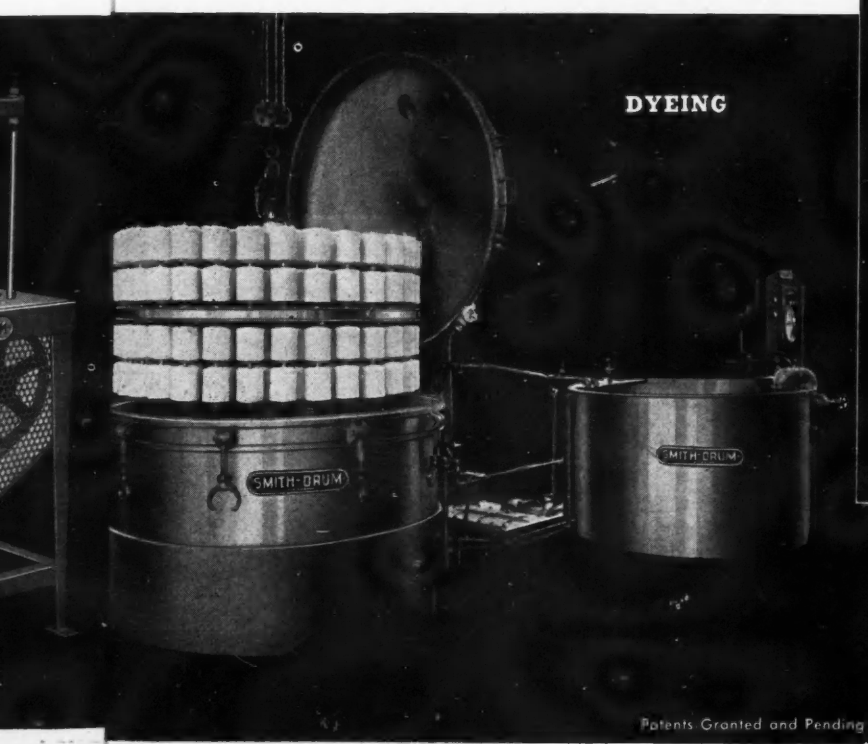
SMITH, DRUM & COMPANY
Allegheny Ave. at 5th St., Philadelphia 33, Pa.



Patents Granted and Pending



Patents Applied For



Patents Granted and Pending

QUALITY DYESTUFFS

SINCE 1878

JOHN CAMPBELL & COMPANY, INC.

75 HUDSON STREET • NEW YORK CITY

TELEPHONE: BArclay 7-6228-6229

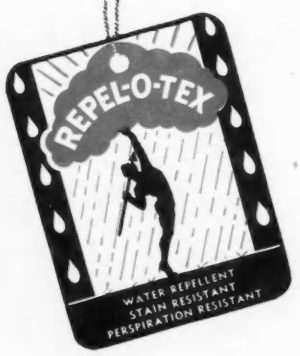
PHILADELPHIA: BROAD AND SPRING GARDEN STS.

BRANCH OFFICES AND WAREHOUSES:

BOSTON EAST CLEVELAND, OHIO ATLANTA, GA.

REPEL-O-TEX
D3 & D4

for Low Cost...
Durable Repellency



REALLY LASTING water repellency on cotton-rayon, cotton-acetate and many all rayon, acetate and nylon constructions is provided by Repel-O-Tex D3 and D4. Yet the cost is no greater than that of ordinary fugitive repellent finishes.

Easy to apply in jig, pad or quetsch. No curing . . . no scouring . . . no extra handling operations. Applicable to other fabrics than those enumerated above, with excellent effects of less durability.

May we arrange for a trial run?

Onyx Oil & Chemical Company

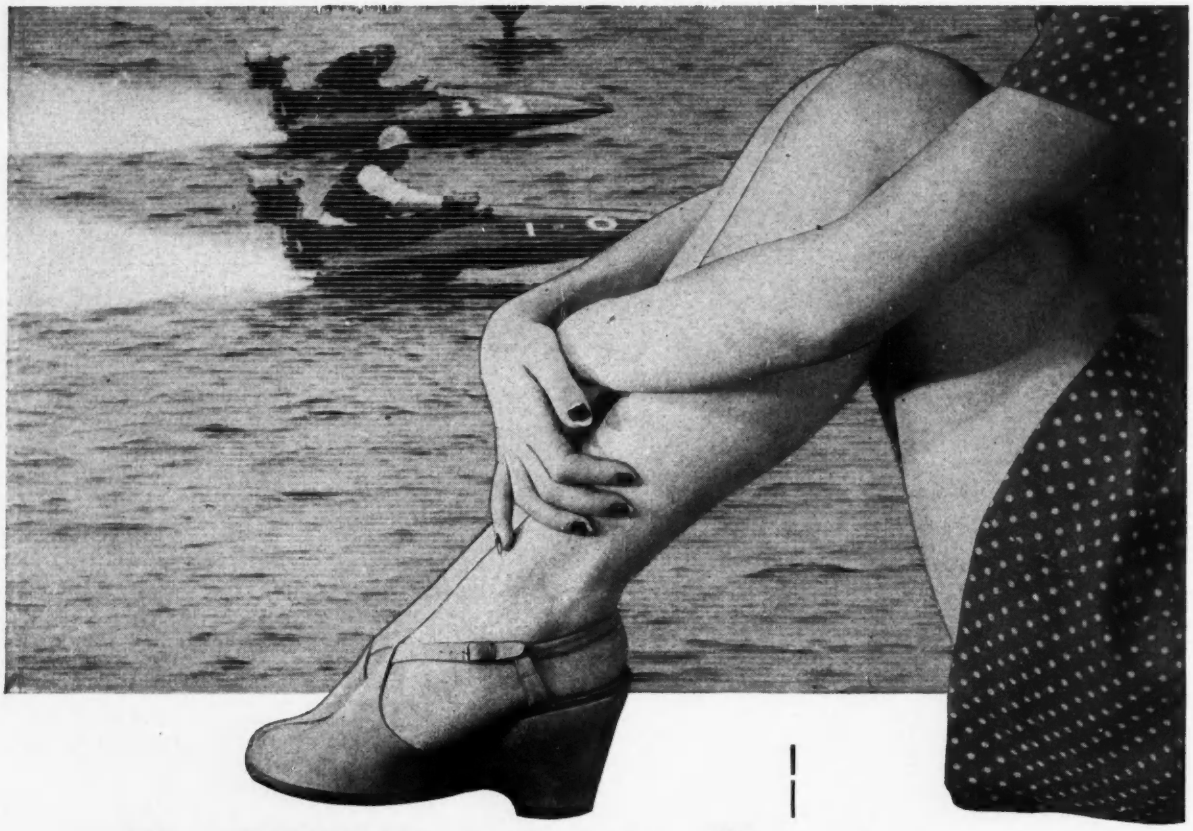
JERSEY CITY 2, N. J.

CHICAGO • PROVIDENCE • CHARLOTTE • ATLANTA • LOS ANGELES

In Canada: Onyx Oil & Chemical Co., Ltd., Montreal, Toronto, St. Johns, Que.

For Export: Onyx International, Jersey City 2, N. J.

onyx **CHEMICALS FOR DYEING AND FINISHING**



The FINISH tells the Story!

In sports or sales, the finish tells the story. When buying hosiery or other textile products, today's exacting customer demands "good looks."

For wet-goods processing of all types there is a standard or special Fancourt formula designed for your product. No matter what your finishing problem, Fancourt experience and "know-how" will create a *winning finish* for you.

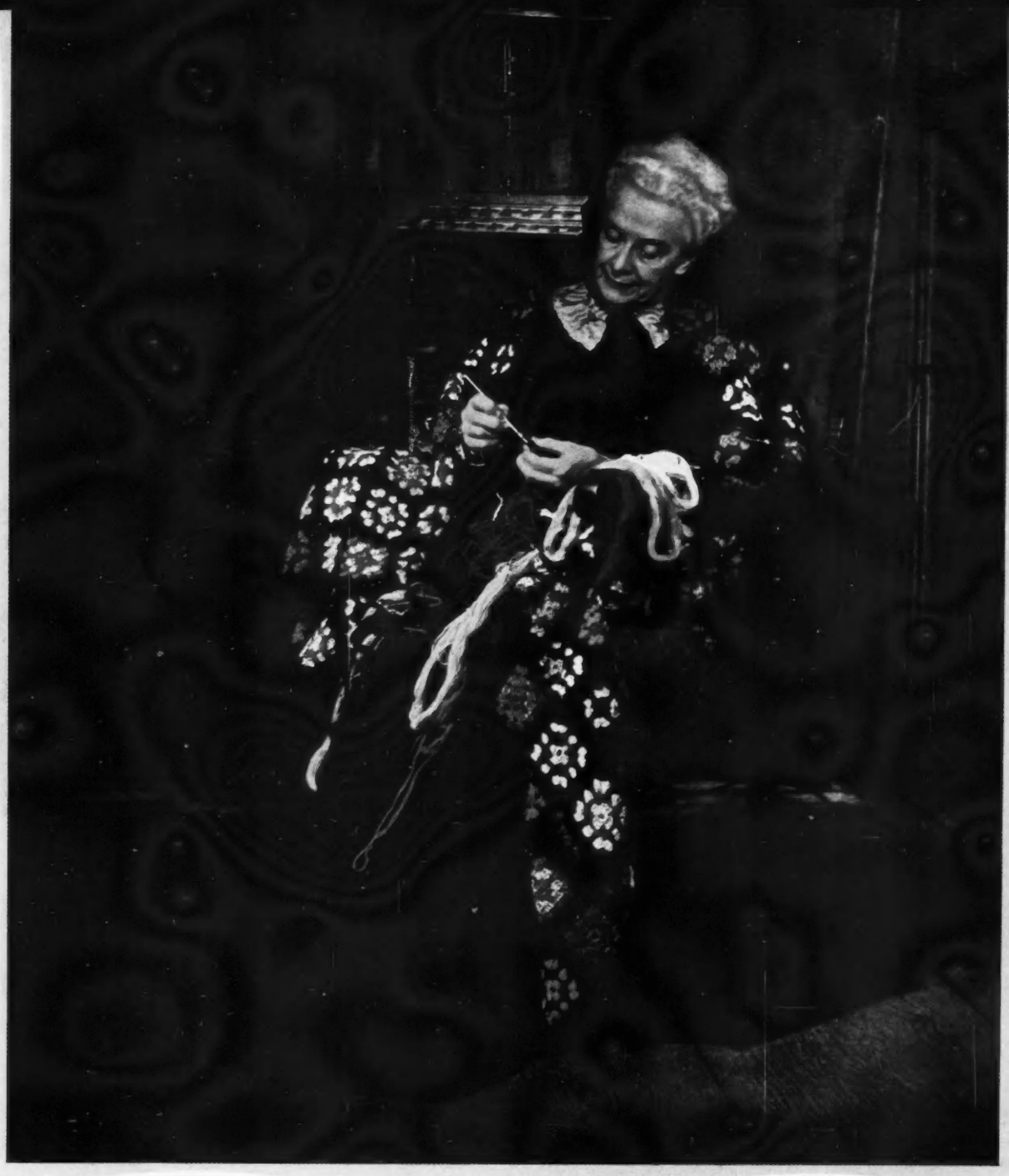
Aquapel—the ideal spot and water repellant . . . for all textile products.

W. F. FANCOURT & CO.

PHILADELPHIA, PA.

In the South, Howard A. Virkler, Greensboro, N. C.

Solving Finishing Problems Since 1904



Afghan made entirely from 5-gram matched samples gathered from National Aniline's nationwide application laboratories.

WHEREVER COLOR IS USED

SPECIFY *National Aniline Dyes*

NATIONAL ANILINE DIVISION • ALLIED CHEMICAL & DYE CORPORATION

40 RECTOR STREET, NEW YORK 6, N.Y. BOSTON • PROVIDENCE • PHILADELPHIA • CHICAGO • SAN FRANCISCO • PORTLAND, ORE. GREENSBORO • CHARLOTTE • ATLANTA • NEW ORLEANS • CHATTANOOGA • TORONTO

Orange—L'atelier d'impression, par Rossetti, 1764, tapisserie peinte sur toile.
Courtesy Columbia University Library

Manufacture of the printed fabric or *toile imprimee* was depicted on a series of panels by Joseph Gabriel-Marie Rossetti, designer at Orange, France, in 1764. The tapestry above shows proprietors and workers in the print shop.

Cloth was stretched on a table and a "block", or wood engraving covered with color, applied to it. When a number of shades were desired, additional colors were painted on with fine brushes.

By 1782, the copper-plate printing press was introduced, permitting designs of greater variety and perfection.

In the modern process of printing, as in those of dyeing and finishing, rapid and dependable de-sizing is accomplished with

RAPIDASE

WALLERSTEIN COMPANY, INC. 180 Madison Ave., New York 16, N. Y.

Lanascour

DREW'S NEW WOOL SCOURING AGENT

Combines the well-known advantages of soap with the most desirable qualities of synthetic detergents.

LANASCOUR **was developed on specific suggestion from leading wool processors**

FOR GREASE WOOL SCOURING
YARN SCOURING
BACK WASHING TOP
PIECE GOODS WASHING

A perfectly balanced compound

Mill Demonstrations Solicited

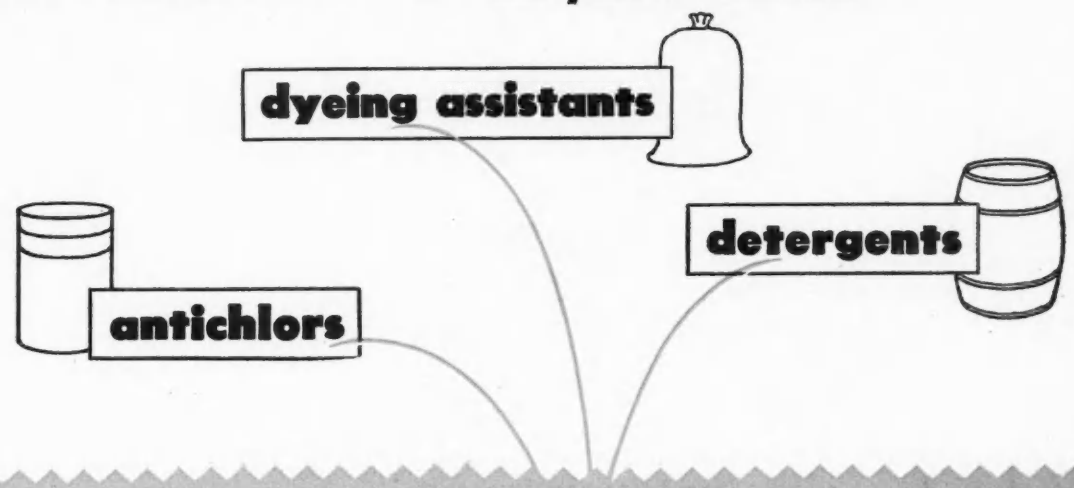
E. F. DREW & CO., INC.

15 EAST 26th STREET • NEW YORK 10, N. Y.

• FACTORY & LABORATORIES: BOONTON, N. J. •

CANADA	BOSTON	CHICAGO	BRAZIL
E. F. Drew & Co., Ltd. Montreal	Chamber of Commerce Bldg., Zone 10	919 N. Michigan Ave., Zone 11	E. F. Drew & Cia., Ltd. Rio De Janeiro

ONE SOURCE for dependable



SPECIFY "GENERAL CHEMICAL"

Color—finish—production efficiency—these are largely dependent upon the quality, purity and uniformity of the textile chemicals you use. For certainty in your selection of basic chemicals . . . specify "General Chemical."

General Chemical's "know-how" as a producer of industrial chemicals, plus its long experience in serving the textile field, assures detergents, acids, antichlors, peroxide-stabilizing agents and dyeing assistants of the utmost dependability.

GENERAL CHEMICAL COMPANY

40 Rector Street, New York 6, N. Y.

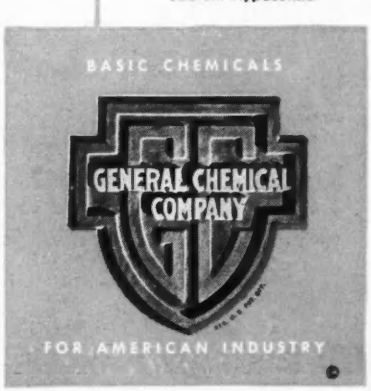
Sales and Technical Service Offices: Albany • Atlanta Baltimore • Birmingham • Boston • Bridgeport • Buffalo Charlotte • Chicago • Cleveland • Denver • Detroit • Houston Kansas City • Los Angeles • Minneapolis • New York Philadelphia • Pittsburgh • Providence • San Francisco Seattle • St. Louis • Wenatchee • Yakima (Wash.)

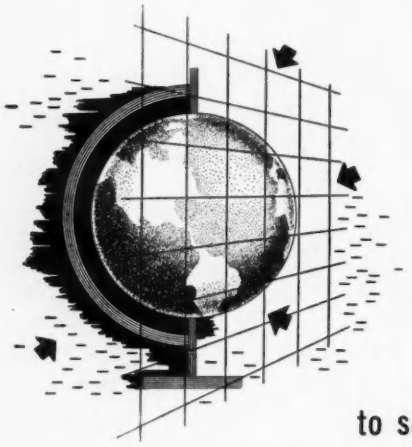
In Wisconsin: General Chemical Wisconsin Corp., Milwaukee, Wis.

In Canada: The Nichols Chemical Company, Limited
Montreal • Toronto • Vancouver

Select Your Basic Textile Chemicals From These General Chemical Products

- Aqua Ammonia
- Acetic Acid
- Hydrofluoric Acid
- Muriatic Acid
- Sulfuric Acid
- Epsom Salt
- Glauber's Salt
- Sodium Bifluoride
- Sodium Bisulfite, Anhydrous
- Sodium Hyposulfite
- Sodium Metasilicate
- Sodium Silicate
- Disodium Phosphate, Anhydrous
- Tetrasodium Pyrophosphate
- Trisodium Phosphate
- Sodium Sulfide
- Oxalic Acid
- Chrome Alum
- Ferric Sulfate *(Iron Copperas Nitrate)*
- Sodium Sulfite, Anhydrous
- Nitre Cake *(Sodium Bisulfate)*
- Nitric Acid
- Mixed Acid
- Aluminum Sulfate
- Lead Acetate
- Aluminum Chloride Solution





Spin the Globe...

There's a FALLEK Representative Everywhere!

Here is your opportunity to secure World Wide Distribution for American Dyestuffs ...

READ THESE FIGURES!

92% of the world's total exports in Coal-Tar Colors, Dyes and Stains were supplied by Europe to the rest of the world.*

4.6% of the world's total exports in Coal-Tar Colors, Dyes, and Stains were supplied by the United States to the rest of the world.*

With foreign production at a minimum level, now is the opportune time for American Suppliers to secure a solid foothold in the most lucrative overseas markets . . . and here is how FALLEK can help you:

FALLEK . . . eliminates costly credit risks. *You receive your check when your goods are ready for shipment* . . . as simple as a domestic transaction, but larger profits.

FALLEK . . . creates an acceptance for your products throughout world markets that assures continuous business.

FALLEK . . . gains you the proper entree with leading firms of known responsibility.

FALLEK . . . gives you intelligent, daily sales coverage through representatives located in every world market.

FALLEK . . . means permanence, through long established outlets in Europe, Latin America, and the Orient.

FALLEK . . . saves you the detail handling and numerous expenses of operating an export department.

FALLEK . . . brings you men of wide experience, men highly skilled in the problems of world distribution . . . plus skilled technicians in every foreign office fully equipped to render all the technical information necessary to users of American Dyestuffs.

American dyestuffs for textiles, leather, paper, etc., are in urgent demand throughout the world. You can realize a sizeable share of this business by making FALLEK your foreign selling agents. THIS is the time to safeguard profits against the hazards of "buyer's market" or a falling off in domestic demand, by developing a substantial export volume. FALLEK can do this for you.

**U. S. Tariff Commission Report No. 19 last pre-war figures*

WRITE, WIRE OR PHONE FOR FURTHER INFORMATION.

FALLEK PRODUCTS COMPANY, INC.

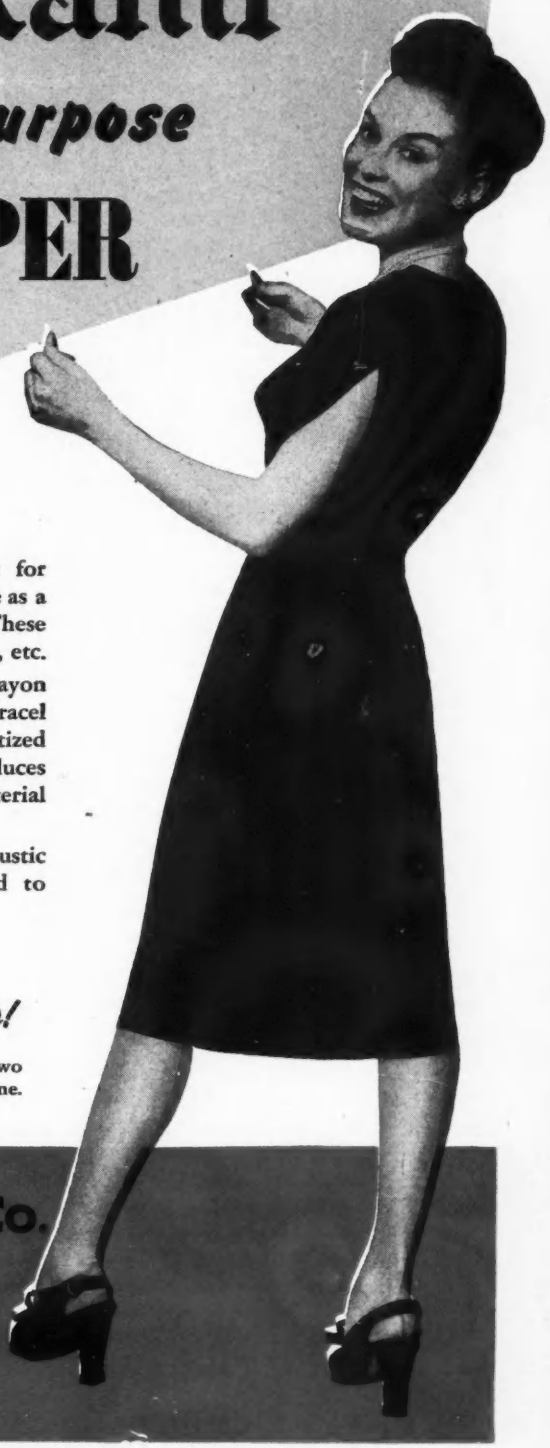
149 BROADWAY • NEW YORK 6, N. Y.

SPECIALISTS IN ORGANIC CHEMICALS

Hydroxanil

the Multi-Purpose

DEVELOPER



HYDROXANIL is not only excellent for acetate and nylon blacks but also finds extensive use as a developer for rayon and cotton developed colors. These include Diazo Black BH, Diazo Green 3G, Primuline, etc.

Wash-fast developed blacks on acetate and rayon combination materials may be obtained by using Maracel Developed Black A and Diazo Black BH diazotized and developed with Hydroxanil. This method produces greater wash-fastness than when this type of material is dyed with acetate and direct blacks.

Hydroxanil is simple to use—requires no caustic soda. Simply stir into boiling water and add to developing bath.

...Develops Complete in 30 Minutes!

No excess rinsing or soaping required! Two batches dyed in the time usually required for one.

MARCO PRODUCTS

MAHER COLOR & CHEMICAL CO.

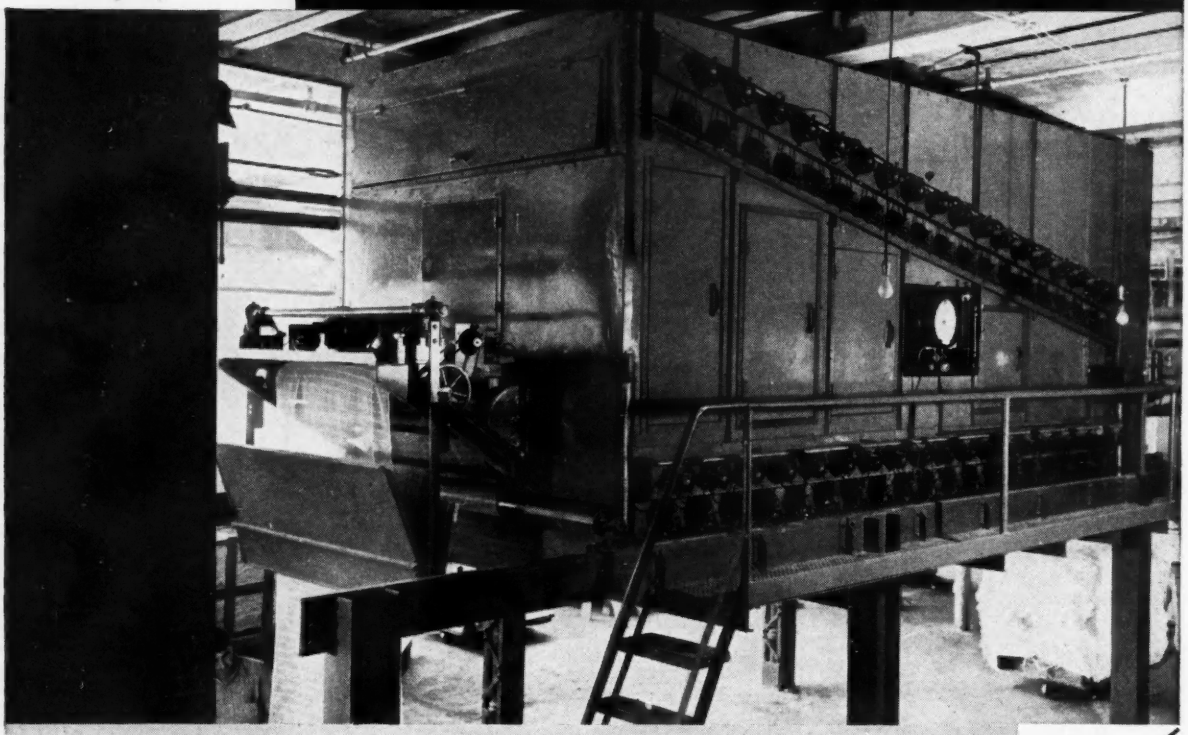
FACTORIES AND LABORATORIES

355 West Ontario Street, Chicago 10, Ill.

2327 East Eighth Street, Los Angeles 21, Calif.

Engineered

FOR CURING RESIN TREATED FABRICS



PROCTOR *Roller* CURER

The Proctor roller curer, illustrated, is in daily use in curing curtain material, an application to which this machine is ideally suited.

The material to be cured is conveyed through the curing chambers by means of individually motor driven rolls. This method of conveying is especially effective in the handling of light materials, such as marquisette. It holds the goods taut without tension, for the speed of the rolls varies with even the merest suggestion of tension. The material is carried through the machine at high speeds and subjected to temperatures of about 350°F. The heating medium in this machine is gas, although the same high temperatures can be obtained with high pressure steam. Individual analysis of cost and other factors involved make it possible to determine which of these two heating mediums is most advisable in any particular case.

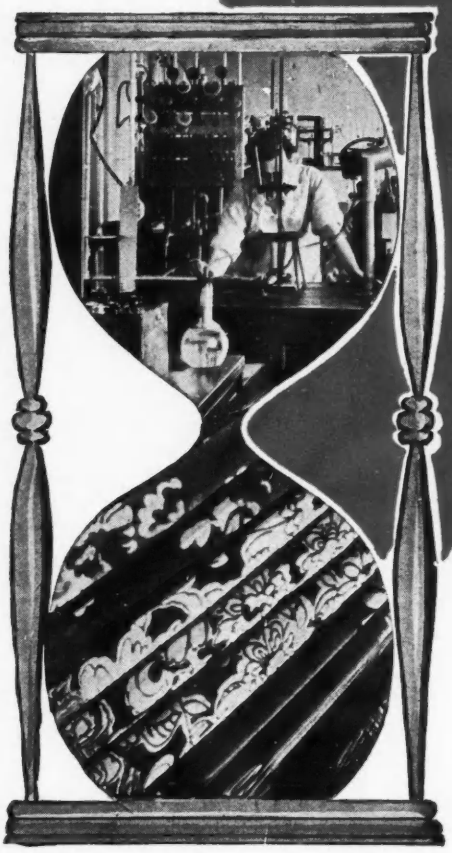
In the particular installation shown, the curer is "suspended" from the ceiling—or elevated from the floor, in such a way as to provide working space beneath. Such an arrangement is ideal where floor space is at a premium, and is another example of how Proctor equipment is individually designed to meet specific plant requirements.

If you are engaged in the production of resin treated fabrics, you should investigate this and other Proctor equipment that may help you to a more efficient curing job and less cost. Write for details today.

PHILADELPHIA 20, PA. **PROCTOR & SCHWARTZ INC**

25 YEARS

OF CHEMICAL PRODUCTION TECHNICAL AND RESEARCH SERVICE TO THE TEXTILE INDUSTRY



1922 — 1947

Since 1922, Standard Chemical Products, Inc., has concentrated on supplying the Textile Industry with a complete line of processing and finishing agents, formulated to meet the needs of the latest advances of textile chemistry. Each product is manufactured under strict laboratory supervision . . . carefully balanced to meet the most exacting requirements of operation and fiber.

Why not submit your problems or special needs to us, without obligation? Technical field representatives are conveniently located in leading textile centers to render mill service at all times.

25 YEARS OF CHEMICAL SERVICE TO THE TEXTILE INDUSTRY

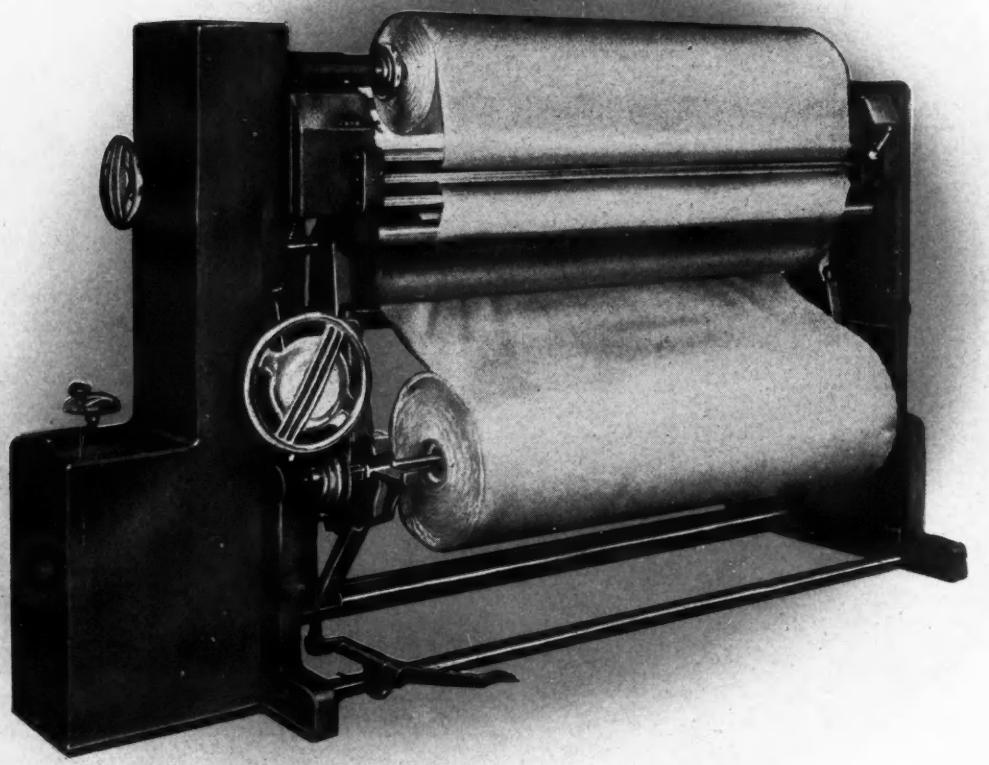
S C.P.Inc REG. U.S. PAT. OFF.

STANDARD CHEMICAL PRODUCTS, Inc.

1301 JEFFERSON STREET, HOBOKEN, NEW JERSEY

HIGH POINT, N. C. · LEAKSVILLE, N. C. · PATERSON, N. J.
CHATTANOOGA, TENN. · PROVIDENCE, R. I. · SACRAMENTO, CAL.

ONE OF VAN VLAANDEREN'S COMPLETE LINE OF MACHINES



TIME TESTED, NOW EVEN BETTER

This Van Vlaanderen Tubing Machine has done excellent work through the war years. Now it has been improved to process up to 250 yards a minute and to take larger diameter rolls on tubes.

Operation of the machine is through mechanical controls within easy reach of the operator. Cloth speed is constant and measuring is accurate and dependable. Ball bearings are used throughout. Motor has 1-3 variable speed drive. Lubricated parts are sealed in oil.

Write for descriptive leaflet

VAN VLAANDEREN MACHINE COMPANY

370 STRAIGHT ST., PATERSON 3, NEW JERSEY

World's largest manufacturer of machines for processing modern fabrics

SUNfast and SEAfast...

CALCOFAST* wool dyes

Because of their exceptional all-round fastness properties, Calcofast Wool dyes are ideal for use in quality bathing suits and beachwear.

Specifically, the Calcofast Wool dyes Yellow N, Pink N, Orange RN, Blue 2G and Bordeaux RB Conc. are *the* "seaside colors," the colors most in demand for producing the bright, rich shades that will stand up to sunlight and salt water. And, like all Calcofast Wool dyes, they are fast to carbonizing, fulling and perspiration, assure good penetration, and produce consistently level, uniform shades.

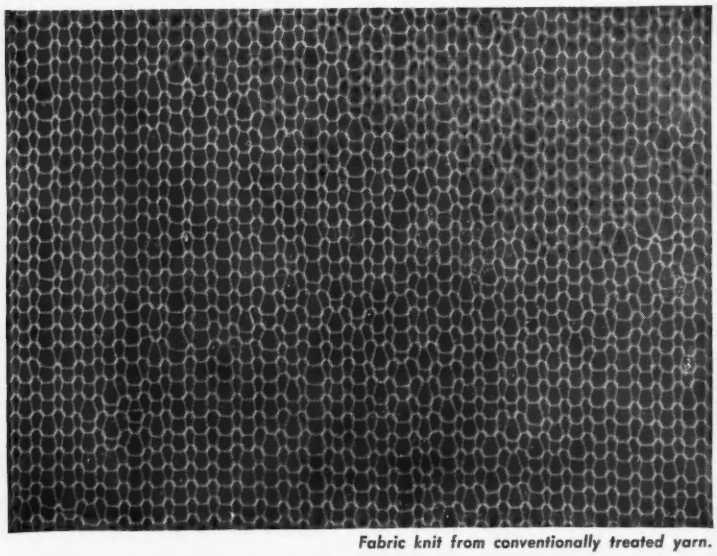
Your Calco representative will give you full information on this group of metallized dyes for carbonized wool. CALCO CHEMICAL DIVISION, AMERICAN CYANAMID COMPANY, Bound Brook, New Jersey.
New York, Chicago, Philadelphia, Boston, Charlotte, Providence.

*Trademark

Reprints of this advertisement suitable for framing and without text will be sent on request.

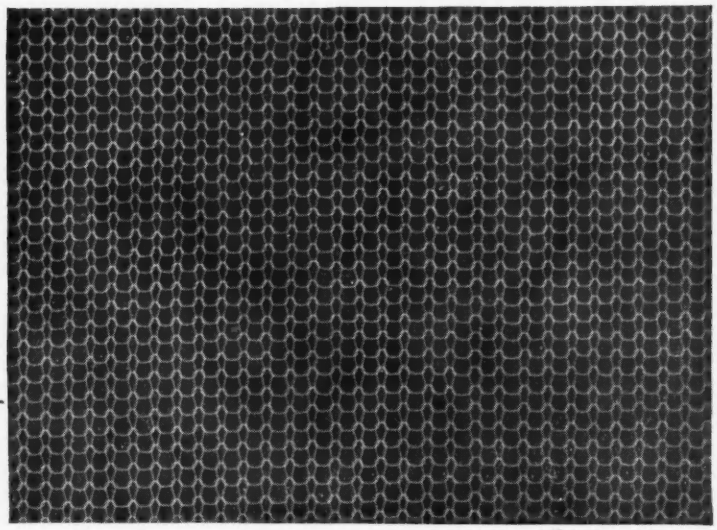
Calco

Is your stitch like this



Fabric knit from conventionally treated yarn.

or like this



Fabric knit from KŌNRITE *treated yarn.*

For the treatment of yarns for truly fine hosiery, Nopco presents KŌNRITE, a new and unique nylon coning oil. In Coning, Knitting, Seaming, KŌNRITE offers you:

OUTSTANDING RESULTS...

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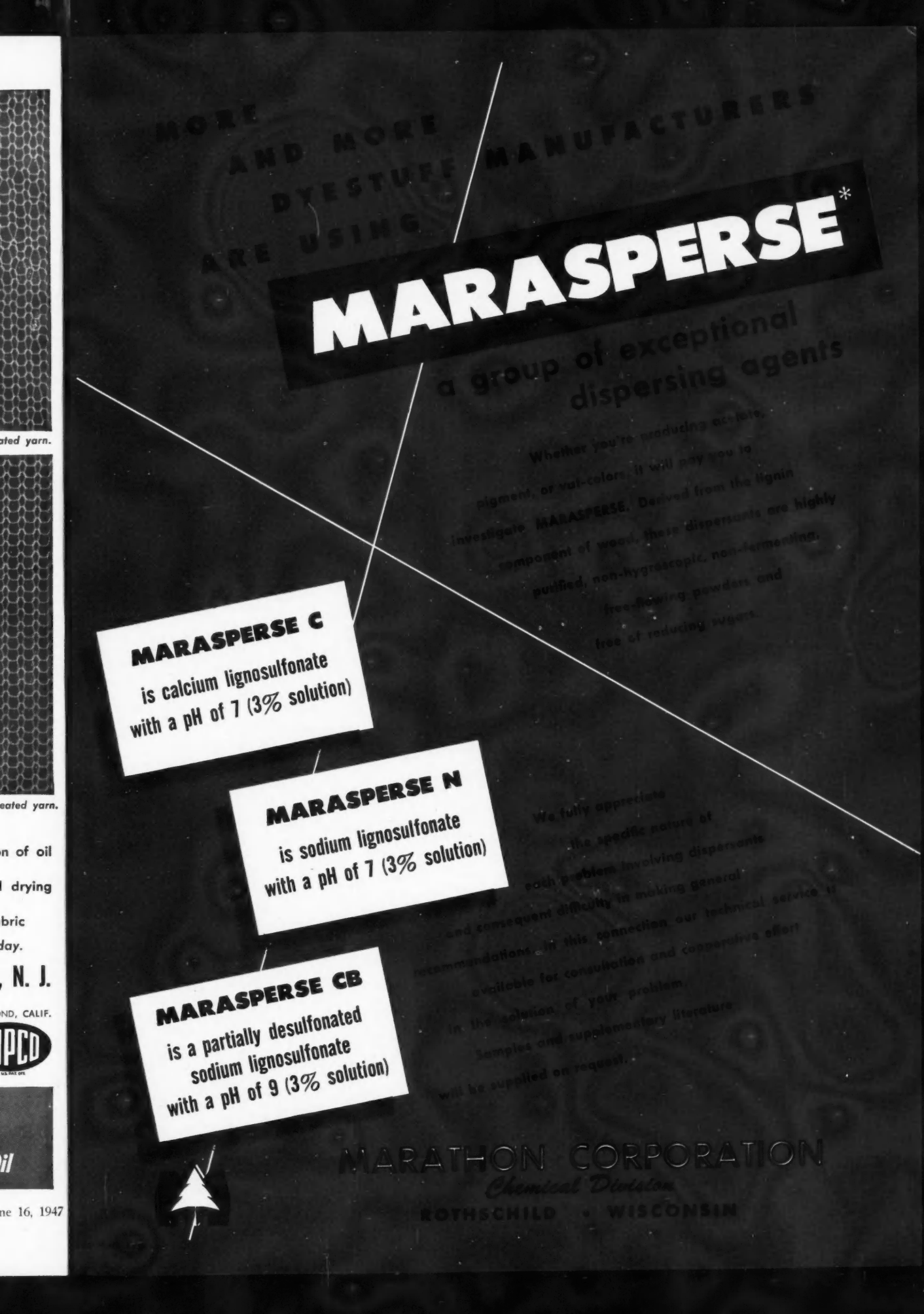
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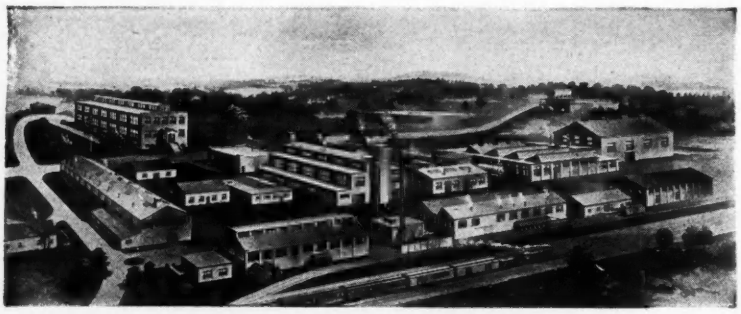

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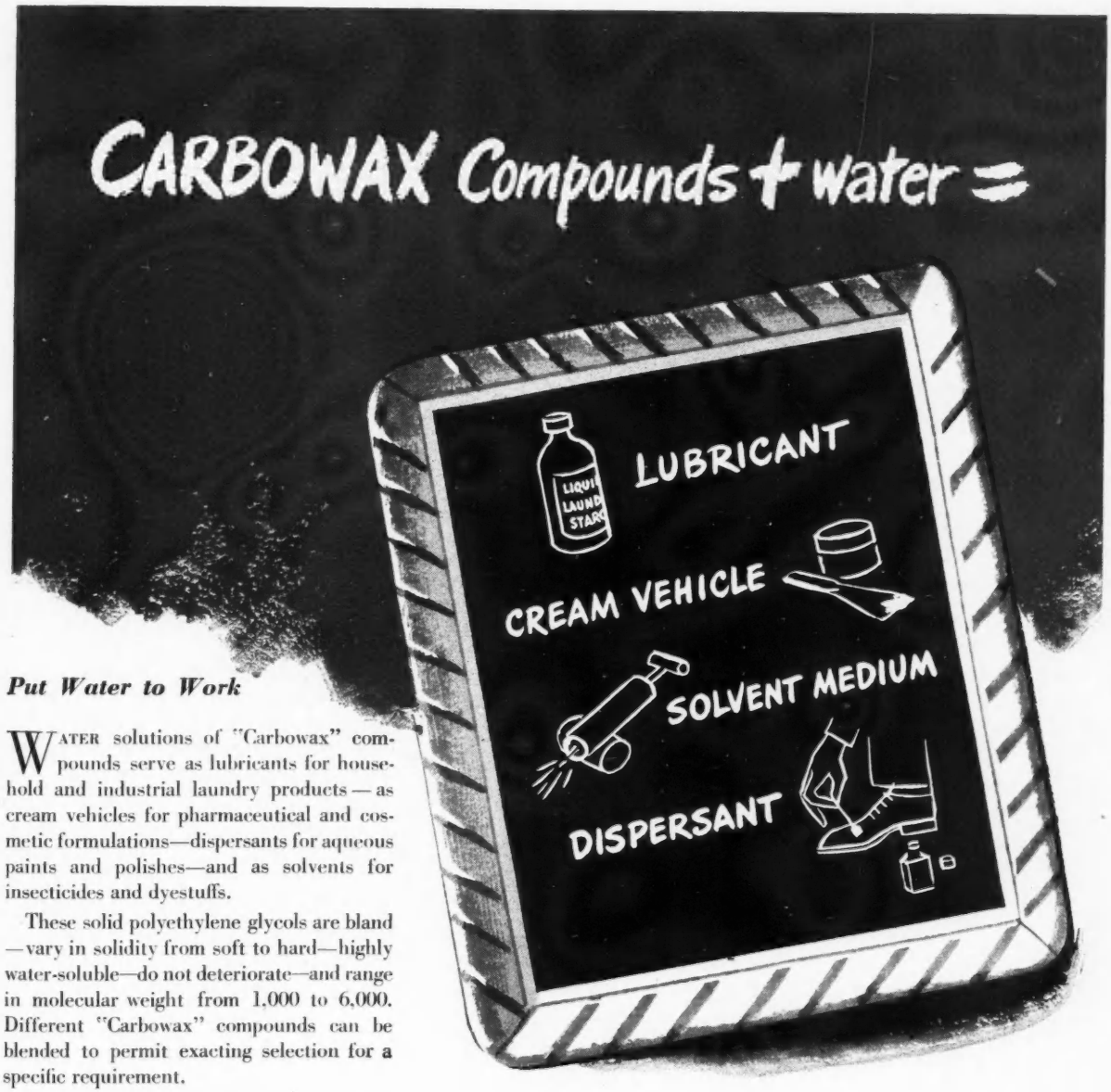

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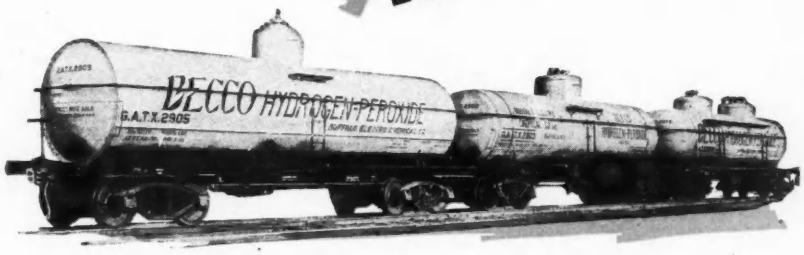

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June 16, 1947

VOLUME 36 NUMBER 12

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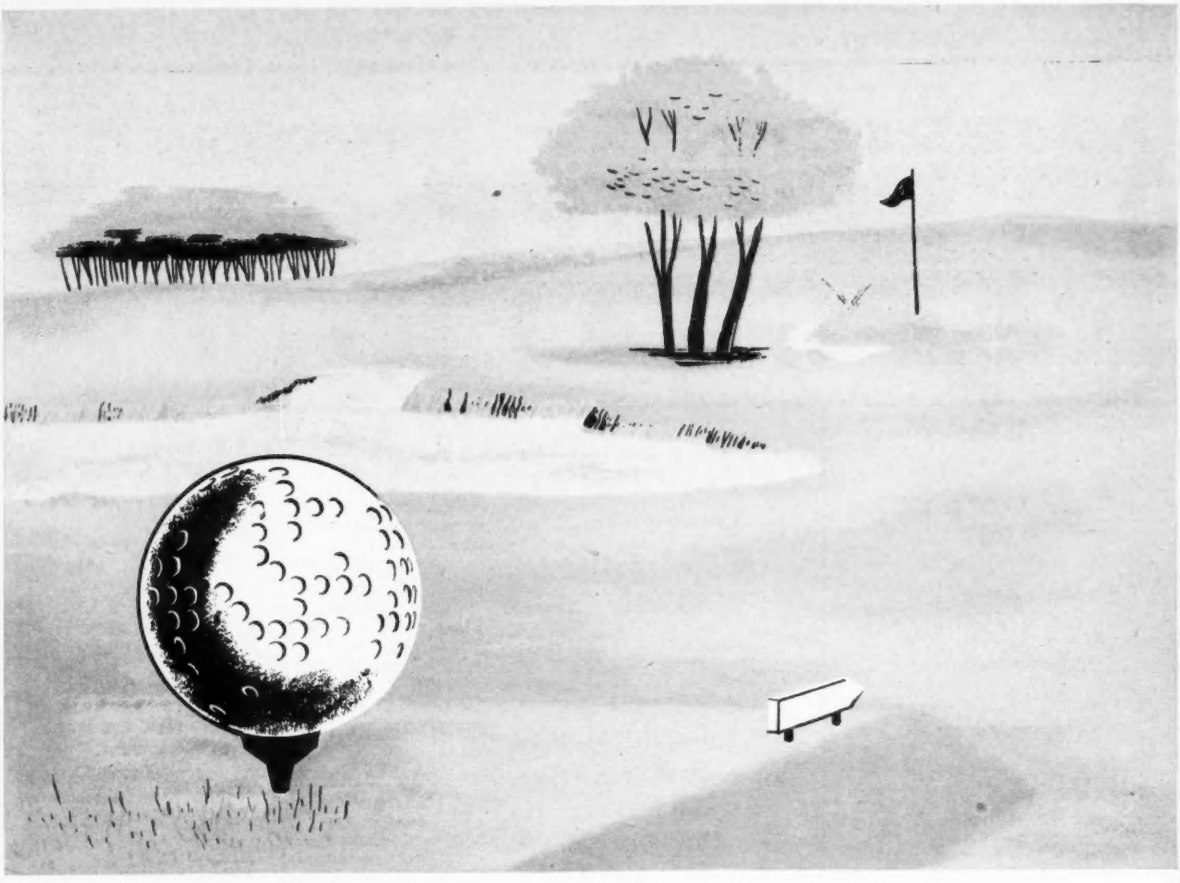

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DYESTUFF REPORTER

VOLUME 36 June 16, 1947 NUMBER 12

Quantitative Analysis of Igepon T

D. A. SHIRAEFF
General Dyestuff Corporation

THE analysis of sulfonated surface-active agents has always presented a great problem to the chemist in textile mills. For the evaluation of purchased materials and the determination of running concentrations of baths, no suitable analytical procedure has been available. A search through *Chemical Abstracts* since 1916 failed to reveal any direct method for the quantitative determination of Igepon T.

Realizing this problem, our research department undertook the investigation of the analytical properties of the sulfonated surface-active agents which we merchandise for the purpose of developing a simple and direct method of analysis.

Below we are giving a detailed procedure for the analysis of sodium salts of oleyl methyl tauride which are our Igepon T brands and also the data representing the actual analysis of two commercial brands of Igepon T.

In the present article we are presenting the method for the analysis of Igepon T but, it is also suitable for a number of other synthetic surface-active substances which contain sulfonic acid in the molecule, such as alkyl, alkylarylnaphthalene sulfonates and sulfated fatty alcohols. However, the procedure for the aalysis of these products require modifications and we hope to present the data which we have on these in future communications.

Principle

Igepon T is quantitatively precipitated from strongly acid solutions by benzidine hydrochloride. The precipitated benzidine salt of Igepon T is easily filterable and is easily washed with water free from mineral acid. This salt is separated from soap by washing with petrolic ether. The benzidine salt of Igepon is fairly soluble in an alcohol-water mixture. This solution can be titrated with caustic soda or evaporated and the residue dried to constant weight. Sulfates do not interfere with the determination. The high concentration of acid either prevents completely the precipitation of benzidine sulfate or allows only a partial precipitation when the sulfate concentration is too high. In the latter case, however, the benzidine sulfate is separated from the benzidine salt of Igepon T by alcohol, in which benzidine sulfate is insoluble.

Reagent

Benzidine Hydrochloride
25.7 gm. Benzidine Hydrochloride—
50 cc HCl Conc.
per L.
Petrolic Ether
Alcohol-water Mixture
800 cc Alcohol and 200 cc water
0.02% N. Caustic Soda Solution

Procedure

Prepare a solution of Igepon T of concentration such that 50 cc of it contains from about 0.1 to 0.4 gm. of 100% Igepon T. Filter this solution and pipet 50.0 cc of it into a 150-cc beaker. Add 5.0 cc of Conc. HCl, bring to the boil and add slowly 50 cc of benzidine hydrochloride solution. After allowing to stand for several hours or overnight filter the precipitated benzidine salt of Igepon through a 9-cm. Whatman No. 41H filter paper. Wash the precipitate and the filter paper free from acid until the washings are neutral to blue litmus paper. Transfer the precipitate and the filter paper into a 100-cc beaker, place it for a short time in an oven to dry. Add 50 cc of petrolic ether to the beaker with the precipitate. Filter the ether extract through a 9-cm. Whatman No. 40 filter paper. Continue washing the Igepon precipitate with 10-cc portions of ether until 100 cc are used. Transfer the second filter paper into the same 100-cc beaker, let the last traces of the petrolic ether evaporate, then add 50 cc of the alcohol-water mixture (800 cc alcohol and 200 cc water) and place the beaker on a steam bath. Work out the precipitate until completely dissolved, then filter while hot through a 7-cm Whatman No. 40 filter paper into a 100-cc volumetric flask. Keep washing the beaker with 10-cc portions of the alcohol-water mixture and filter the washings into the same 100-cc volumetric flask until the total filtrate is about 100 cc. When the filtrate has cooled down to room temperature, bring the filtrate in the flask exactly to the 100-cc mark, mix well and pipet 50.0 cc into a 150-cc beaker, add a few drops of phenolphthalein and titrate with 0.02 N caustic soda. When the end point of the titration is within 1-5 cc add 50 cc of distilled water. Titrate to the end point in the cold, and then bring the content of the beaker to the boil and complete the titration. From the total amount of the caustic soda used in the titration, subract the amount of caustic soda necessary to titrate the 50 cc of the alcohol-water mixture and 50 cc of distilled water.

Calculation:

$$\frac{(\text{cc NaOH} \times \text{Normality}) \times 425.5}{\text{Oven dry weight of sample} \times 1000} \times 100 = \% \text{ Igepon T}$$

(425.5 is the molecular weight of Igepon)

As an alternate procedure, or as a check on the titration, an aliquot of the alcohol-water solution of the benzidine salt of Igepon can be pipetted into a tared 50-cc Erlenmeyer flask, the solvent evaporated and the residue dried to constant weight.

$$\frac{\text{The weight of residue} \times 0.8586}{\text{Oven dry weight of sample in the aliquot}} \times 100 = \% \text{ of Igepon T}$$

$$0.8586 = \frac{2\ (\text{Igepon T})}{\text{Benzidine Salt of Igepon}}$$

Analysis of two Commercial Brands of Igepon T

IGEPON T GEL

20.000 g. of Igepon T Gel were dissolved in 500.0 cc.

50.0 cc of the above solution were taken for analysis. Igepon T was precipitated and freed from soap by washing with petrolic ether. The precipitate dissolved in alcohol-water mixture and brought to 100.0 cc in a 100-cc volumetric flask. 50.0 cc of this solution were taken for the titration (Table I) and 25.0 cc were evaporated and weighed (Table II).

IGEPON T POWDER

9.840 g. of Igepon T Powder were dissolved in 500.0 cc.

50.0 cc of the above solution were taken for the analysis. Igepon T was precipitated and freed from soap by washing with petrolic ether. The precipitate dissolved in alcohol-water mixture and brought to 100.0 cc in a 100-cc volumetric flask. 50.0 cc of this solution were taken for the titration (Table III) and 25.0 cc were evaporated and weighed (Table IV).

TABLE I

Sample	*Wt. of sample taken for the analysis*	*Wt. of sample taken for titration*	*NaOH Titration*		*Igepon T Found*	
			cc of 0.0203 N used	*cc of Normal calculated*	*Weight*	*%*
A	2.000 g.	1.000 g.	16.15 cc	0.328 cc	0.1396 g.	13.96%
B	2.000 g.	1.000 g.	16.25 cc	0.330 cc	0.1404 g.	14.04%
C	2.000 g.	1.000 g.	16.15 cc	0.328 cc	0.1396 g.	13.96%
D	2.000 g.	1.000 g.	16.30 cc	0.331 cc	0.1408 g.	14.08%
Mean of the four determinations			.....	.....	.....	14.01%

The molecular weight of Igepon T is taken as 425.5.

TABLE II

Sample	*Wt. of sample taken for the analysis*	*Wt. of the precipitate*	*Factor of Igepon T / precipitate*	*Igepon T Found*	
				Weight	*%*
A	0.500 g.	0.0816 g.	0.8586	0.07006 g.	14.01%
B	0.500 g.	0.0820 g.	0.8586	0.07041 g.	14.08%
C	0.500 g.	0.0815 g.	0.8586	0.07006 g.	14.01%
D	0.500 g.	0.0825 g.	0.8586	0.07083 g.	14.17%
Mean of the four determinations					14.07%

TABLE III

Sample	*Wt. of sample taken for the analysis*	*Wt. of sample taken for Titration*	*NaOH Titration*		*Igepon T Found*	
			cc of 0.0203N used	*cc of Normal calculated*	*Weight*	*%*
E	0.984 g.	0.492 g.	16.70 cc	0.339 cc	0.1442 g.	29.31%
F	0.984 g.	0.492 g.	16.55 cc	0.336 cc	0.1430 g.	29.06%
G	0.084 g.	0.492 g.	16.65 cc	0.338 cc	0.1438 g.	29.22%
H	0.984 g.	0.492 g.	16.50 cc	0.335 cc	0.1425 g.	28.96%
Mean of the four determinations			.....	.....	.....	29.15%

Molecular Weight of Igepon T is taken as 425.5.

TABLE IV

Sample	*Wt. of Sample taken for the analysis*	*Wt. of the precipitate*	*Factor of Igepon T / precipitate*	*Igepon T Found*	
				Weight	*%*
E	0.246 g.	0.0837 g.	0.8586	0.07186 g.	29.21%
F	0.246 g.	0.0834 g.	0.8586	0.07161 g.	29.11%
G	0.246 g.	0.0832 g.	0.8586	0.07144 g.	29.04%
H	0.246 g.	0.0825 g.	0.8586	0.0708 g.	28.78%
Mean of the four determinations					29.04%

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Fundamental Research Session

Silver Jubilee Convention, Boston, Mass., December 13, 1946

THE Fundamental Research Session was held in the Grand Ballroom of the Hotel Statler, on Friday, December 13, 1946, with Walter J. Hamburger opening the session at 9:30 o'clock in the morning.

Chairman Hamburger: I want to welcome you all here this morning, and to express the appreciation of the Technical Program Committee for such a fine turn-out, particularly in view of the fact that we have made quite a drastic change in the type of program which we are presenting at the national convention this year. We would be pleased to have your comments, criticisms and suggestions, because as Mr. Linberg indicated last night, these conventions are now becoming of such sizeable proportions that we shall need the cooperation of members of all the sections in order that we may continue to progress in the next twenty-five years, as we have in the past.

I apologize for a late start, but after yesterday's experience, I found that at least for once a large group of Americans, can relax and leisurely get places instead of pushing their way around. It took us quite a while to get the banquet group in last night, which is certainly an unusual experience; usually they storm the doors at 7:30 to get in.

The program, as indicated, will allot forty minutes to each speaker for the presentation of his paper, to be immediately followed by a ten-minute question period. In view of the fact that the proceedings of this session, as well as this afternoon's session, are being stenotyped, we ask that those who present questions to the speakers give their names so that they may be heard and recorded.

I now take pleasure in presenting Professor Edward R. Schwarz, who will be in charge of the morning session.

[Professor Schwarz then assumed the Chair.]

Chairman Schwarz: Mr. Hamburger has already suggested that the program this year is a little bit different from what it has been in the past.

It is a matter of pleasure and satisfaction to me to see a group as large as this for a Fundamental Research Session, as there was doubt in the minds of some that the members would respond to such a program, and this is obviously the answer. In order to keep it on the level to which we hope it will be carried through and to set a precedent, I am going to make the introductions very short, and in the form of a semi-citation. That gives it an academic atmosphere which perhaps is appropriate.

The first paper of the morning is on "New Developments in the Chemical Modification of Wool" and introduces the first of the original Big Three of the fibers of the textile industry. The speaker, long associated with this Association, is the recipient of the second Olney Medal Award, and is a world-wide recognized authority in his field, a respected scientist, a leader in textile research, and I don't have to tell you a grand, good fellow.

I give you Milton Harris, Director of the Milton Harris Associates, of Washington, D. C. [Applause]

[Dr. Harris then read his prepared address.]

* * * *

New Developments in the Chemical Modification of Wool*

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Introduction

THE modification of the properties of natural and synthetic fibers and fabrics made from them has been one of the most important fields of textile research and development. In general, most work along these lines has involved the more or less superficial or surface treatment of the fabrics with a compound or a formulation such that specially desired properties are imparted to them. Thus, fabrics may be treated to make them water-repellent, fire-resistant, shrink-resistant, fungus- and mothproof, to improve resiliency, to make them more stiff, to make them softer, or to alter them in many other ways. This, in short, is what is now widely known as chemical textile finishing.

Another approach, which has received far less attention, but which appears to offer a potentially lucrative field of research, is that which involves the chemical modification of the molecular structure of the fiber itself for the purpose of altering its properties or better adapting it for a given end use. True, there has been a limited amount of work done in this direction. For example, partial acetylation of the cotton fiber to decrease its moisture absorption and thus improve its electrical properties has been used in England to a limited extent. The Southern Regional Research Laboratory has applied similar reactions to cotton fabrics and in this way has produced fabrics with exceptionally good resistance to attack by fungus, bacteria, etc. The treatment of both protein and cellulosic fibers with such reagents as formaldehyde, glyoxal, acetic anhydride, ketene, etc., undoubtedly belong in this category, although in many cases, the exact nature of the reactions involved is not clearly understood.

A number of years ago [*1, 2, 3*] a series of researches on the molecular structure of the wool fiber demonstrated that the chemical structure of this fiber could be altered in such a way as to profoundly affect its chemical, biological, and mechanical properties. Unfortunately, the reactions involved were impractical and prohibitively expensive and the results proved of greater academic than practical interest. More recently, the problem of modification of the

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wool fiber has been taken up again in this laboratory, and the work has resulted in the development of new, simple, inexpensive methods for accomplishing the same result. It is the purpose of this discussion to describe briefly the nature of these reactions[1] and to point out some of their practical implications.

Review of Earlier Work

At the outset, it appears appropriate to review very briefly the pertinent facts about the molecular structure of wool and its bearing on some of the more important characteristics of wool fibers and fabrics. Perhaps the outstanding property of wool is its long range elasticity; that is, its ability to recover from distortions of considerable magnitude after it has been stretched, crumpled, or compressed. This elasticity is primarily responsible for the success of wool in producing fabrics which are distinguished (1) by unusual shape-holding qualities or resistance to creasing and mussing, and (2) by low bulk density, or the ability to entrap much air which makes them eminently suited for the production of cold weather clothing, blankets, etc.

It is now generally accepted that this elasticity results from the fact that wool, like rubber, synthetic elastomers, and other fibrous proteins is composed of long, flexible, molecular chains which tend to exist in more or less folded or coiled configurations. During deformation, as occurs in a stretching process, there is apparently an opening of these folds or coils to a more nearly straight chain configuration. The elastic characteristics result from the tendency of the flexible chain molecules to contract from the less probable stretched state to a more random form.

Based on present knowledge of fiber structure, a fiber, made up of coiled or folded flexible molecules, would be expected to have very low strength and indeed it can be demonstrated that this would be the case in wool were it not for this fiber's most distinguishing molecular characteristic, the presence of covalent disulfide cross-links between these main chains. Accordingly, when wool is subjected to various types of stresses, the molecular chains cannot slip past one another but instead tensions are set up by the cross-links and once the external force is removed, the fiber returns to its original shape. In short, the cross-links have the all important function of strengthening the fibers, especially in the wet state, and suppressing plastic flow; and in this connection, it can be shown that the role of these cross-links is analogous to vulcanization in rubber [2].

Unfortunately, these cross-links are easily destructible; they are responsible in a large measure for the sensitivity of wool to alkalis, oxidizing and reducing agents, and to its edibility by moths. Earlier research led to the prediction that if these cross-links could be broken and rebuilt in a stable form, many of the defects of wool could be eliminated or minimized and its desirable properties retained. This subsequently proved feasible through a series of reactions involving the reduction of the disulfide linkages with thioglycollic acid followed by rebuilding the ruptured links with trimethylene dibromide according to the following reactions:

(1) $W\text{-}S\text{-}S\text{-}W + 2HSCH_2COOH \rightarrow 2WSH + (SCH_2COOH)_2$

(2) $2WSH + Br(CH_2)_3\,Br \rightarrow W\text{-}S\text{-}(CH_2)_3\text{—}S\text{—}W + 2HBr$

The reconstituted wool formed according to equation 2 showed greatly increased resistance to attack by alkalis, oxidizing and reducing agents and moths, even when only one-half of the disulfide cross-links were changed to the new linkages. However, the cost of the chemicals alone for modifying one-half of the cross-links exceeded $1.50 per lb. of wool treated and at least six hours were required for the conversion, a totally impractical system indeed.

Discussion of New Reactions

It is apparent from the foregoing discussion that any practical applications of "reconstituted wool" would have to await the development of a much cheaper and more practical process. One obvious way to accomplish this would be to utilize the much cheaper inorganic reducing reagents, such as the hydrosulfites, sulfoxylates, etc., which are capable of splitting disulfide cross-links. Attempts to substitute these materials for thioglycollic acid as used in the earlier process proved unsuccessful in that they produced boardy fabrics with a considerable loss in tensile strength.

The marked difference in properties of fabrics modified by the thioglycollic acid-trimethylene dibromide method and by a similar method in which inorganic reagents have replaced thioglycollic acid indicate that very different chemical reactions are involved. The principle difference apparently is in the nature of the split obtained during the reducing step. When thioglycollic acid is used, a symmetrical split is obtained; that is, two sulfhydryl groups are formed and accordingly during alkylation, each group is equally capable of reacting with the alkyl dihalides to rebuild the original cross-links. In contrast, when sodium hydrosulfite is used, an unsymmetrical split is obtained as shown in the following reaction:

(3) $W\text{-}S\text{-}S\text{-}W + Na_2S_2O_4 \rightarrow WSNa + WS\,S_2O_4\,Na.$

In this case, the products of the reaction are undoubtedly not equally reactive and during alkylation there could be a tendency for two sulfhydryl groups, which are not both from the same original disulfide group, to react with both ends of an alkyl dihalide, to form an entirely new and different cross-link. This would invoke a considerable amount of molecular rearrangement, a possibility that would be considerably enhanced by the excessive swelling that occurs during reduction with hydrosulfite at the high temperatures and alkalinities used. In short then, the original molecular structure has now been considerably altered with the accompanying deterioration of desirable properties.

At this stage of the work, an interesting possibility suggested itself. If cross-links could be rebuilt as soon as the disulfide groups were split, such molecular rearrangements with their deleterious effects could not occur. One possible way to accomplish this would be to incorporate both the reducing agent and the alkylating agent in the same treating solution, a feature that was not feasible when thioglycollic acid was used since thioglycollic acid reacts readily with the alkyl dihalide itself. In other words, a one step process would be used in place of the earlier two-step process.

Treatment of the wool by a one-step method dramatically confirmed the above hypothesis. The treated fiber or fabric retained its strength, elasticity, and desirable hand, at the same time acquiring a marked increase in resistance to attack by alkalies and other chemical agents. In addition, it was shown that cross-linking of the ruptured disulfide links could be accomplished in this process with such agents as formaldehyde and glyoxal as well as with alkyl dihalides. The reactions probably follow the pattern shown below in equations (4) and (5):

(4) $W\text{-}S\text{-}S\text{-}W \xrightarrow[Br_2(CH_2)_2]{Na_2S_2O_4} W\text{-}S\text{-}(CH_2)_2\text{-}S\text{-}W$

(5) $W\text{-}S\text{-}S\text{-}W \xrightarrow[CH_2O]{NaHSO_2.CH_2O} W\text{-}S\text{-}CH_2\text{-}S\text{-}W$

The striking difference in the properties of the materials prepared by the one-step and two-step processes are shown in Tables 1 and 2.

Examination of the data in Tables 1 and 2 further emphasizes the difference between the one-step and two-step process. In treatment (3) in both Tables, all of the sulfhydryl groups have reacted with either formaldehyde or ethylene dibromide, and therefore it must be concluded as pointed

[1] The technical details of this work will be discussed in a series of forthcoming publications.

TABLE 1
Comparison of the Properties of Wool Treated with Sodium Sulfoxylate Formaldehyde and Formaldehyde

Treatment	30% Index*	Sulfhydryl Group Test	Feel	Strength
(1) None	0.98 to 1.0	Negative	Excellent	.....
(2) Sodium sulfoxylate formaldehyde	.46	Positive	Boardy	Weak
(3) (2) followed by formaldehyde	.63	Negative	Boardy	Somewhat stronger
(4) Sodium sulfoxylate formaldehyde plus formaldehyde	.94	Negative	Excellent	Same as original

* The 30% index is the energy required to stretch a fiber to 30% elongation after a treatment divided by the similar energy requirement prior to the treatment.

TABLE 2
Comparison of Properties of Wool Treated with Sodium Hydrosulfite and Ethylene Dibromide

Treatment	30% Index	Sulfhydryl Test	Feel	Strength
(1) None	0.98 to 1.0	Negative	Excellent	.....
(2) Sodium hydrosulfite	.10	Positive	Very boardy	Very weak
(3) (2) followed by ethylene dibromide	.13	Negative	Very boardy	Very weak
(4) Sodium hydrosulfite plus ethylene dibromide	.84	Negative	Excellent	Same as original

out earlier in this discussion that the original cross-links have not been replaced by new links, but rather that a change or rearrangement of molecular structure must have occurred to produce the profound changes in properties of the fabrics. On the other hand, the results obtained with treatment (4) can only be interpreted to mean that the overall molecular structure of the fiber has been maintained while converting the unstable disulfide groups to more stable forms.

It is also of special interest to compare the economics of the original and present processes. In contrast with a minimum processing time of six hours and a chemical cost of $1.50 in the earlier work, the one-step process can be completed in 30 minutes or less at a chemical cost of about 3 cents per pound of wool treated. The great rapidity of the one-step process must result from the fact that the products of the reaction in equation (3) are immediately removed thus driving the reaction to completion.

Practical Implications

There are many practical implications of this work, some of which have been investigated but most of which are in the process of being investigated. The stabilization of cross-links is of potential value in producing wool of enhanced resistance to attack by biological agents and by chemical reagents such as oxidizing and reducing agents and alkalies. It will immediately be obvious that many wool processes involve the use of these chemicals with more or less deleterious effects, among the well-known ones being stripping, bleaching and vat-dyeing. The results of a few preliminary experiments which indicate the applicability of stabilizing cross-links to these processes are given below.

Stripping: Stripping is a process which is used to remove color from a dyed textile, generally in order to correct dyeing faults or in reclaiming wool for the reworked or reused wool trade. The primary requirement for a good stripping process is that fiber should suffer as little damage as possible; that is, its strength, spinning and milling properties should not be excessively impaired. Actually however most commercial stripping processes result in considerable damage to the wool fiber largely through attack on the disulfide cross-links. Since the most widely used stripping processes involve the use of hydrosulfites or the sulfoxylates, it will be readily seen that the addition of a suitable linkage rebuilding agent to the stripping bath will eliminate or minimize much of this type of damage. That this is actually accomplished is shown by the data in tables 3 and 4.

The data in table 3 were obtained on virgin raw stock in order to obtain tensile strength measurements. The samples described in table 4 are samples of re-used wool or shoddy. These materials do not lend themselves to tensile strength measurements but some idea of their condition is obtained by the alkali-solubility method. The high alkali-solubilities of the unstripped fiber indicate considerable damage which is accentuated by the regular commercial strip but improved by the new method. A comparison of the hand and feel of the stock stripped by the various methods also shows the superiority of the new process. It should be pointed out that the sodium hydrosulfite-ethylene dibromide treatment is the preferred new method for stripping since the use of formaldehyde as a linkage-rebuilding agent in this process tends to interfere with the actual stripping of the dye.

Bleaching—For the most part, bleaching is practiced to remove the natural color of the fiber. If the color is light, and a mild bleach can be used, not much damage is incurred but if the fibers are dark, as are many animal hair fibers, the bleaching process must be so severe as to seriously degrade the fiber. Again it can be demonstrated [4] that a main point of attack of the oxidizing agent is on the disulfide groups.

Only one preliminary experiment on the bleaching of the modified wool has been conducted thus far and a totally unexpected result was encountered. When a sample of very dark brown alpaca was pretreated by the sodium hydrosulfite ethylene dibromide procedure, very little change in color or strength of the fiber was found. The untreated and stabilized samples were then bleached with hydrogen

TABLE 3

Treatment	Tensile Strength lbs./in.²	Alkali-Solubility
		%
(1) Untreated	17,000	12
(2) Sodium hydrosulfite + Ethylene dibromide	17,000	7
(3) Sodium sulfoxylate-formaldehyde + formaldehyde	16,000	3
(4) Zinc sulfoxylate-formaldehyde (commercial strip)	14,000	24

TABLE 4
Alkali-Solubilities of Samples of Re-used Wool Stripped with a Regular Commercial Strip and with Sodium Hydrosulfite Plus Ethylene Dibromide

Treatment	Alkali-Solubility	
	Sample No. 1	Sample No. 2
	%	%
(1) None	52	17
(2) Commercial strip	62	22
(3) Sodium hydrosulfite plus ethylene dibromide	21	9

peroxide under identical conditions and after a given length of time, the color of the modified sample was very much lighter than that of the original material. The entire behavior of the modified fiber was such as to indicate a much greater reactivity towards peroxide, a phenomena which still remains to be investigated.

Summary and Conclusions

A new method for stabilizing wool to the action of certain chemicals such as alkaline, oxidizing and reducing agents has been developed. The method involves the conversion of the unstable disulfide cross-links to a more stable form by simultaneously rupturing the links and rebuilding them. This is accomplished by treating wool with a single solution containing a reducing agent such as sodium hydrosulfite and a rebuilding agent such as ethylene dibromide. In contrast with earier work which involved a long, impractical and prohibitively expensive two-step method for modifying wool in this way, the new one-step method is rapid, simple and inexpensive.

Although the practical implication of these studies have only been investigated in a very preliminary way, it appears that unusual results may be obtained by application of these reactions to such industrial processes as stripping, bleaching and vat dyeing.

Literature Cited

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Discussion

Mr. Figdor: Are there any changes in the shrinkage properties, or felting properties, in the new treated woolen materials?

Dr. Harris: There is nothing very profound. I ought to point out to you, that almost anything you do to wool always decreases the felting shrinkage a certain amount, depending upon how severely you have treated it. We get a small decrease in feltability, but nothing that is too significant.

Mr. Uzenoff: Dr. Harris, in your remarks on the increase of resistance of wool towards alkali, you mentioned only the ethylene dibromide. Would not formaldehyde do the same thing?

Dr. Harris: If you have an excess of formaldehyde, you can accomplish it. There is one thing that is bad, as far as stripping is concerned; namely, the formaldehyde apparently interferes with the stripping and you get poor stripping. With the dibromide, you get better stripping; that is why we prefer the dibromide over the formaldehyde. On the other hand, in producing alkali-stable wool, we prefer formaldehyde and the chemical costs are less than half.

Mr. Uzenoff: Is the ethylene dibromide in emulsified form?

Dr. Harris: Yes. We make an emulsion.

Mr. Mytella: We have worked with methylene and ethylene groups. What would be the effect of such work on the properties of wool?

Dr. Harris: Actually, we have worked with chains up to about ten carbon atoms, and that produces a long cross-link. When the carbon chain is long, and the wool is wetted, it swells excessively, and you haven't accomplished anything. The new process can be accomplished with ethylene, and in contrast with trimethylene it is the cheapest of all dibromides. In general, you don't accomplish much, and the material gets poorer and poorer, as you increase the chain length of the dibromide.

Mr. Altenbaumer: We talk about increased stability of wool. Now, would the same wool be increased in strength after treatment of the fiber with sulfuric acid?

Dr. Harris: Actually, we are interested in these reactions in increased stability to reagents which attack the disulfide linkage. Sulfuric acid does not attack it, but it does attack the peptide linkages.

May I go to the blackboard for a moment. What actually happens is this. If you keep breaking down units of structure in a molecule, then the smaller the material becomes, the more soluble it becomes. If you damage wool with carbonizing, you break peptide linkages, and you get many more smaller molecular units. Even though you have only stabilized the disulfide links, you have still accomplished much. Thus if you assume you have two poly-peptides which you subject to the carbonizing process and you make a break here [indicating on blackboard], that isn't too bad. Those of you who carbonize wool know you are fortunate to get only a few breaks; but something else is holding the wool together, or you wouldn't have any fiber. If you stabilize these disulfide linkages, and still only have the break here [indicating], the overall structure is more stable and you are better off than you were before.

Mr. Walker: What are the concentrations of the reagents involved in this process, in terms of the wool, and, secondly, does the treatment with sodium hydrosulfite and ethylene dibromide result in more resistant wool to attack by moths?

Dr. Harris: I will answer the second part first. We haven't had a chance to put these things through moth tests yet. As far as the first part is concerned, the concentration of chemicals used will depend upon how many links you want to break and rebuild. In general, the reactions I have shown are accomplished with concentrations used commercially. In other words, 4 per cent of sodium hydrosulfite on the weight of the wool was used.

Mr. Walker: About what order of magnitude have you found it necessary to use for the ethylene dibromide?

Dr. Harris: We use a maximum concentration of ethylene dibromide of 10 per cent on the weight of the wool, which is about two cents worth of chemical.

Mr. Wood: At what temperature were they used?

Dr. Harris: They were used in typical commercial runs, which started, I think, around 50 degrees Centigrade or so and went up to 85 degrees in this particular sample. We can actually run the temperature up, because we are not hurting the wool.

Mr. Wood: What alkalinity?

Dr. Harris: pH 8. The sulfoxylate was used at a lower pH, as practiced in a large stripping plant.

Mr. Jones: What effect, if any, does it have on the affinity of the wool for dyestuffs?

Dr. Harris: It doesn't change it at all.

* * * *

Chairman Schwarz: I think we will have to move on. I am quite sure that other questions are going to be answered in the paper that Dr. Harris has promised us. We could spend the rest of the morning on it.

The second paper deals with cotton, rather than wool, in order that we shall not show undue partiality. The title is "Fundamental Aspects of the Prevention of the Microbiological Degradation of Cotton Textiles" by Dr. Ralph G. H. Siu, Director of the Biological Laboratories, Philadelphia Quartermaster Dept.

There are a number of us in the educational field and a number, also, in industry, who, for some years, have been preaching as vociferously as we might the necessity, increasingly, for cooperation between the textile technologist, be he physicist, chemist, engineer or what-not, and the biologist and the botanist, and the histologist, possibly. There is that need existing, and we are beginning to recognize it, and perhaps in answer to these prayers we have a chance to listen this morning to a man who is expert in both fields. The importance of his work is evidenced by the fact that he is at present Director of the Biological Laboratories at the Philadelphia Quartermaster Depot and he is in charge of Fundamental Biological Research for the Quartermaster Corps. From Hawaii, by way of California to Philadelphia, I give you Dr. Siu! [Applause]

* * * *

Fundamental Aspects of the Prevention of the Microbiological Degradation of Cotton Textiles*

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Abstract

As a result of intensive work on the problem by the Quartermaster Corps, the N.D.R.C. and collaborating institutions, over 10,000 cultures of microorganisms have been isolated from deteriorated cotton fabrics. Of these, about 200 cultures have shown to possess cellulolytic ability. It is doubtful, however, whether all these are of considerable importance under field conditions. In attacking the cotton fiber the fungal hypha penetrates the fiber wall into the lumen where it proliferates and digests the cotton fiber outwards. Bacteria, on the other hand, adhere to the outer surface and pit their way inwards. In both cases, the attack appears to be a highly localized affair with degradation occurring only at the point of the fiber in immediate contact with the microorganism.

The organisms secrete cellulose-digesting enzymes. So far, these have been classified into 2 classes, viz.: (a) cellulase, which converts cellulose into cellobiose and (b) cellobiase, which converts cellobiose into glucose. Cell-free preparations of these cellulose-degrading enzymes have been made and their properties extensively studied.

There are 4 general lines of approach to the development of preventive methods, viz.: (1) physical prevention of organism from making contact with the cellulose molecule, as illustrated by the resistance of resin-impregnated cloth, (2) cell toxicants, as exemplified by fungicides, (3) specific enzyme inhibitors which exist today as a theoretical possibility, and (4) chemical modification of the cellulose molecule, which appears to be very promising for future exploitation.

Introduction

THE significance of the microbiological degradation of cotton textiles was first impressed upon the military mind during the early days of the South Pacific Campaign of the last war. Coupled with warm temperatures, the prevailing dampness of the Tropics stimulated microorganisms to degrade tentage and clothing at a very rapid rate. Typical reports of this wide damage is a British one estimating that the loss attributable to microbiological degradation in the Ordnance Depots in India for the last three months of 1944 alone amounted to about a quarter of a million dollars (*1*). During those arduous days of war the financial losses were even overshadowed by the tactical and morale setbacks. Faced with the urgency for a solution of the problem, the Quartermaster Corps began concerted efforts towards the development of microbiologically-resistant cotton fabrics. The necessity for an immediate stop-gap measure, at least, left no alternative at the outset but to work with what we knew and had. This meant that efforts were considered only in relation to the availability of large scale commercial processing. The resulting program of research was based primarily on the empirical development of fungicides, which could be applied to the cloth in the piece by standard textile machinery.

While this program resulted in a temporary relief, it soon was recognized that progress was being hampered by the lack of information concerning even the most elementary and basic aspects of the question. In cognizance of this state, an active and extensive program was initiated on the elucidation of the fundamental facts of the problem. I should like to survey the highlights of such investigations and their relation to the development of sound preventive methods. Most of the data to be presented represent work that has not been published. It is expected, however, that a monograph on the subject will be put out by the Quartermaster Corps in the not too distant future.

Essentially, the program was divided into 3 phases:

(1) What are the identity and physiology of the organisms concerned?
(2) How do these organisms bring about the degradation?
(3) Based on this fundamental information, what preventive methods can be developed?

Cellulolytic Microorganisms

As far as the organisms are concerned, about 70 species of the 10,000 cultures of fungi, bacteria, and Actinomyces isolated by our laboratories and collaborators from deteriorated fabrics have been shown to be capable of degrading cellulose. These organisms vary greatly in their ability to degrade cellulose. The fungus, *Myrothecium verrucaria*, and the bacterium, *Sporocytophaga myxococcoides*, are among the most active, being able to reduce the tensile strength of cotton cloth to zero within a week under optimum conditions. Other species like *Cladosporium herbarum* cause a reduction in tensile strength of only about 25 per cent in 2 weeks.

Although these organisms can attack cellulose in an otherwise inorganic medium, there are others which require the addition of organic substances. *A. niger*, J745, is an example of one requiring the addition of yeast extract; *Memnoniella echinata* requires biotin.

Besides this differential nutritional requirement among different microorganisms, their cellulolytic activity is also greatly influenced by the environment. Temperature and pH are important considerations, which have been studied extensively in the Quartermaster laboratories. The pH of the medium influences the rate of cellulolytic action to such a significant extent that for comparable results either in experimental work or specification tests, the various factors such as temperature, pH of the medium, and nutritional levels should be controlled rather carefully.

However, the single fact of the classification in the laboratory of the organism as a "strong" cellulose destroyer under specified pH, temperature, and nutrient conditions, does not imply that it is important in the deterioration of fabrics in the field. There are as yet unknown natural operating factors which control their activity in the field. Thus, in all of the field work conducted by the Quartermaster Corps, there is no evidence as yet to indicate that *Myrothecium verrucaria*, which is perhaps the most strongly cellulolytic in laboratory tests, is of great significance in the field. There have been few instances where this microorganism has been observed fruiting on cotton fabrics in the field. The dominant fungi in the field include *Memnoniella echinata* and *Chaetomium globosum*. Under wet field conditions it is highly probable that bacteria, such as the cytophagas, play a significant role in the ultimate breakdown of cloth.

* Presented before the Fundamental Research Session, Silver Jubilee Convention, Boston, Mass., December 13, 1946.

Mode of Histological Attack on Cotton Fibers

Preliminary work has been done by some authors (*2*) on the histological penetration of cotton fibers by microorganisms. In the case of the fungus, it appears as if the hypha penetrates the wall of the fiber, advancing into the lumen. There the fungus proliferates vigorously degrading the fiber from the inside outwards. In the case of bacterial attack, the organism adheres to the surface of the fiber and pits its way inwards. There is rarely an invasion of the lumen by the bacterium until nearly complete degradation of the fiber sets in (*3*). Although these organisms differ in their gross method of attack on the fiber, there is similarity in their highly localized action. The cellulose seems to be degraded only at the point of immediate contact of the organism with the fiber. There appears to be little action at a distance away from this point of contact.

Resin-impregnation as a Preventive Method

This fact offers a premise on which to develop a microbiologically-resistant fabric, viz.: an interruption of the direct contact between the microorganisms and the fiber by an inert physical barrier. This can be accomplished by means of certain resin-impregnations. Small scale laboratory trials have shown this method to be capable of imparting a high degree of microbiological resistance to the cloth.

Cell Toxicants as a Preventive Method

The second rather obvious preventive method, of course, is the use of cell toxicants. Many theories are being advanced to explain the action of fungicides, but they are still in a state of generality. There is the theory of the inhibition of metal catalysis, for example. Zentmyer (*4*) invoked this theory to explain the action of 8-hydroxyquinoline on *Fusarium oxyporum*. This organism is known to require zinc for growth. He found that if the culture medium was enriched with zinc the fungus will grow in the presence of the fungicide. The theory presumes that the zinc is required by the fungus in the form of a free ion and that the hydroxyquinoline forms a complex ion with the small amounts of zinc in the medium. This results in the zinc being made unavailable to the microorganism. But in the presence of extra amounts of zinc, there will be enough free ionic zinc left over after all of the hydroxyquinoline have been tied up.

Other theories of fungicide action involve the disruption of vital enzymatic processes in the protoplasm of the microorganism (*5*). Enzymes consist of 2 parts as a rule, viz.: a protein part and a prosthetic group. The prosthetic group is usually a simple dissociable compound, which is the functional end of the complex. Enzymatic action can occur if the prosthetic group is linked onto the protein part. Certain types of cell toxicants are said to interfere with the normal functioning of these enzymes by denaturing the protein part. Other cell toxicants may interfere with the combination of the prosthetic group with the protein part of the enzyme. Still other toxicants combine with the prosthetic group on the protein in such a strong chemical union that the prosthetic group cannot participate in its normal reactions.

All of these cases result in the elimination of one of the vital agents for life processes in the cell, thereby bringing on death.

As far as tolerances to given cell toxicants are concerned, organisms behave with great variation. The explanation is not entirely clear. It may lay in the differential permeability of the cell walls of various species to the compound. A fungus has been found which grows in very concentrated copper solutions, presumably because the cell wall is impermeable to copper (*6*). Or the reason may lay in a differential capacity for detoxication by the protoplasm of respective microorganisms. In any case, these considerations make it improbable that compounds can be found with equal toxicity for all organisms. If we wish to find a generally effective fungistatic agent for preventing the microbiological breakdown of cotton cloth therefore, we have to work from a different angle based on a knowledge of the mechanism of degradation of cellulose.

Specific Enzyme Inhibitor as Preventive Method

When we begin to investigate more in detail as to what happens to the cellulose micelles and cellulose molecules during the microbiological degradation of the cotton fiber, we begin treading on strange grounds. Available hypotheses concerning this phase of the work need much experimental support before they can be accepted. For example, the suggestion has been made that microorganisms preferentially remove the amorphous cellulose. It has been claimed (*7*) that this initial removal of amorphous cellulose, which were presumed to be the elastic cohesive medium between micelles to form fiber units, was the factor giving rise to a decline in tensile strength of the cloth.

As equally preliminary is our experimental knowledge of the biochemical reactions undergone by the cellulose molecules themselves as they are being used by the microorganism as a source of carbon.

We know from our chemical knowledge of the macromolecular nature and insolubility of cellulose that cellulose molecules as such cannot enter the microorganism. Rather, it must first be broken down to yield water soluble products, which subsequently diffuse into the cell. We are particularly interested in the chain of chemical reactions involved in the transformation of the macromolecular compound into water soluble substances. Two types of mechanisms have been proposed, viz.: an oxidative and a hydrolytic one.

The oxidative theory (*8*) assumes that the 6-hydroxy group is converted into the 6-aldehyde, thence to the 6-carboxylic compound. The last is subsequently cleaved into water soluble compounds. Preliminary studies have shown that 6-carboxy-cellulose, as well as cellulose-2,3-dialdehyde, were both resistant to *Myrothecium verrucaria*. These observations, therefore, do not support the oxidative theory.

A hydrolytic route had been previously proposed (*9*), which has been adopted as a working hypothesis by most people in the field. In any case, the conventional transformation for the microbiological degradation of cellulose has stipulated the conversion of cellulose to cellobiose by the enzyme cellulase and the breakdown of cellobiose to glucose by the enzyme cellobiase. In arresting the development of bacteria growing on cellulose at different stages, it is possible to cause cellobiose and glucose to accumulate in the medium, thereby suggesting that cellobiose and glucose are actual products of the enzymatic cellulolytic process. Several people have since confirmed the accumulation of reducing substances (*10, 11* and *12*). Cell-free preparations capable of degrading cellulose have been made. The properties of these enzyme preparations and their relationship to the microbiological cellulolytic process is being studied in Quartermaster laboratories. There seems to be considerable evidence that this hydrolytic equation is probably the actual chain of reactions. Theoretically, we should be able to find inhibitors specific for the cellulase reaction itself. If the first reaction of the chain is stopped, we will not have to concern ourselves with the rest. Preliminary studies indicate some possibilities in this approach. Since it is reasonable to assume that the same or similar mechansm is used by different microorganisms for the degradation of cellulose, an inhibitor developed on this basis will probably be effective against most or all species of cellulolytic microorganisms. Of course, this basis has not been developed sufficiently beyond the theoretical and laboratory stages to make it industrially exploitable today. However, it should be borne in mind in the future development of fungicides.

Chemical Modification of Cellulose Molecules as a Preventive Method

Further considerations of the biochemical mechanism of the cellulolytic process will lead us to the theoretical basis for the fourth preventive method for the microbiological degradation of cotton fabrics. This involves the chemical modification of the cellulose molecules on the surface of the fibers into resistant derivatives. An example of this is the acetylated cloth first tried by Thaysen (*13*) in England, subsequently being carried further by the Southern Regional Research Laboratory in this country. If a substituent is placed at the proper hydroxyl group or groups on the cellulose molecule, it will eliminate susceptibility of the cloth to microorganisms.

This may be due to either one or both of the following reasons:

(1) The group on the cellulose molecule which normally is the point of attack by the microorganisms may be changed so that the requisite biochemical reaction can no longer take place. This results in the non-digestibility of the cellulose derivatives on the fiber surface.

(2) The substituent introduced may change the steric pattern of the cellulosic substrate so as to interfere with the action of the enzymes secreted by the microorganism. In the light of present day theories of enzymatic reactions, the molecular shape of the enzyme secreted by the organism must fit the shape of the cellulose molecule before the breakdown of cellulose can take place. If a chemical substituent is introduced into the cellulose molecule, the steric pattern of the substrate is modified; the resulting cellulose derivative is no longer sterically compatible with the enzyme secreted by the organism; the subsequent enzymatic reaction cannot occur; and the derivative is thereby not susceptible to the microorganism. Since the surface of the fiber is coated with this resistant derivative and since, as we have said before, the action of microorganisms is highly localized, the fiber coated with layers of resistant derivatives will be immune from attack.

Theoretically, as long as we have a firm chemical substituent on the cellulose molecules it will impart resistance to microorganisms. Beyond that, the nature of the substituent does not influence the resistance much. Cooperative experimentation between industry and Quartermaster laboratories has resulted in dozens of different modified cloths, which are resistant to microorganisms. With a bit of extrapolative reasoning, one should be able to pick substituents which impart additional desirable properties other than microbiological resistance to the cloth. Groups with water-repellency qualities should impart both water-repellency as well as microbiological resistance to the cloth if they can be chemically bonded to the cellulose molecule. Through the same process, flame-proofness can be coupled with microbiological resistance by means of a judicious selection of reagents.*

Because of the relatively recent development of this concept of chemical modification, however, we did not have opportunities for sufficient comparisons between the relative permanency of the microbiological resistance as imparted by this method as compared against that obtained through fungicidal impregnations. Theoretical considerations, however, favor the chemical modification method. As discussed previously, the cell toxicants prevent the breakdown of cloth by killing the invading organism. This toxic action takes place through a diffusion of the compound into the cell of the organism, where its action is affected. This necessarily implies a solubilizing of the compound, however slight. In the development of fungicides, therefore, efforts must be directed among other things towards the compound which is not so soluble that it will be leached off by rain easily but yet possesses a solubility sufficient for the exertion of its toxicity upon the cell protoplasm. The chemical modification method, however, operates on a different principle. It is based on the inability of the enzymes secreted by the microorganism to attack the substrate outside of the organism. There is no requirement for a solubility of the cellulose derivatives for its preventive action. As a matter of fact, the more insoluble the derivative the better it is for the purpose. Furthermore, fungicides are usually physically adsorbed on the cloth while chemical substituents in a chemically-modified fabric are integral parts of the fiber surface.

Besides this potential permanence there are other advantages in the use of the chemical modification method, which can be deduced from our previous discussion on the specificity of cell toxicants. We showed that when the method of controlling the action of microorganism is dependent upon the diffusion of a cell toxicant into its protoplasm there is considerable play for differential tolerances by various organisms. We also showed that when the prevention is outside of the cell based on a control of the action of the extracellular enzymes secreted by the microorganism there is great hope for a general control of the action of all cellulolytic microorganisms. Since the chemical modification of cellulose molecules is based on the prevention of extracellular enzymatic action it ought to be effective against most or all cellulolytic microorganisms.

Our fundamental research and small scale developmental work indicated that the method of the chemical modification of the cellulose molecules on the surface of the fiber has very considerable possibilities. We believe that this great promise should be tracked down to its ultimate practical uses, both through further fundamental work to fill in the gaps in our knowledge about the mechanism of action of the microorganisms and larger scale developmental work.

* The "Ban-Flame" finish of Joseph Bancroft & Sons Co. of Wilmington, Delaware, is one of the first developments along this line. It is understood that patents are pending thereon and that licenses may be obtained.

Conclusion

Our preceding discussion suggests that there is sufficient basic information on the subject for us to proceed on the practical solution with surefootedness. We believe that vast practical strides can be made in the near future through proper cooperative efforts between the institutions represented by you here at this meeting and the Quartermaster laboratories.

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Discussion

Mr. Normile: Dr. Siu, is it possible, under certain conditions, that organisms may secrete acidic constituents that may attack the cellulose directly, due to the low acidity rather than the enzyme?

Dr. Siu: Highly improbable. If the pH of the medium is too low, the organism cannot grow. Usually, when the pH of a medium gets down to about 4, the fungus cannot grow. It is unlikely, therefore, that the fungus will secrete anything more acid than that, to cause any damage to cellulose.

Mr. Shaw: What about changing the structure of the molecule by mercerization and its effects on mildew resistance?

Dr. Siu: Mercerization actually increases the mildew action on the cloth. But whether the mercerization process gives you a stable chemical derivative, is questionable. If you have an unstable chemical substituent on a cellulose molecule which will revert back to the original cellulose, naturally the so-called derivative will not be resistant to microorganism.

Chairman Schwarz: If there are no other questions, we are very grateful to Dr. Siu. [Applause]

* * * *

We have seen something so far in the change of chemical linkages that can be brought about. It is of interest because in a current textile journal there is a definite statement made within the last two weeks that such changes have not been accomplished, and that they are impossible. Perhaps we are doing the impossible.

We have seen something of the effect of the biological and bacteriological action on fibers, and the thing that impresses me most and carries me back some years now to Dr. Compton's first coming to M. I. T., when he said that he was concerned about the trends which textile research seemed to be taking; and that he hoped we would come back to what he wanted to call a "bug's eye view" of yarns. Perhaps we are getting down to what is of a magnitude much finer than the fiber surface. We are too prone to think of the fiber surface as it appears to us superficially, or even under the microscope. We fail to realize that the things most profound in their action on the fiber take place at a level lower in order of magnitude, and that the organisms, the reagents which cause the difficulties and produce the advantages which we hope for are acting with atoms and molecules which, to them, are living, and which, to us, are completely invisible and are only understandable by sort of remote control. We should cultivate in our own mentalities a bacteriological mind, and see things as perhaps the organisms do.

The title of the final paper for the morning session is "Some Principles of the Structure of Synthetic Fibers."

It is a satisfaction, always, for one educator to present another educator to any audience. I don't need to expatiate on why it should be done. More than that, it is a great privilege to present the next speaker, and particularly for me to do so. I think you will agree with me that no bibliography following any of our scientific papers for years back would be considered complete, if this gentleman's name had not appeared in it several times. We, then, in the past, have paid tribute and honor to the power of his pen.

For a further significant contribution, we have only to look at the Institute of Polymer Research, which he directs. Again, we should pay tribute and honor to his vision and to his ability.

He is Professor of Organic Chemistry at the Brooklyn Polytechnic Institute: Dr. Herman S. Mark, Director of the Institute of Polymer Research at the Polytechnic Institute of Brooklyn! [Applause]

* * * *

Some Principles of the Structure of Synthetic Fibers*

HERMAN F. MARK

Institute of Polymer Research; Polytechnic Institute of Brooklyn

MY TOPIC is "Some Principles of the Structure of Synthetic Fibers" and the point of general interest seems to be: What are the working principles which a chemist or physicist uses, whenever he wants to build up a fiber from low molecular weight compounds? This interest is great, because as you all know, the number of the available building materials, the so-called monomeric substances increases daily and they are decreasing in price steadily.

What has happened with butadiene and styrene, is happening now with many other monomers.

The processes of polymerization are getting better and better under control, and, therefore, new synthetic fibers are being produced presently and will be produced in future. Those synthetic fibers, to a certain extent will mean competition for the natural materials. However, from a wider point of view, it will mean cooperation, inasmuch as many new and interesting variations and many novel and attractive fabrics can be made by blending the different types of fibers.

Realizing this situation, we have to face the fact that the synthetic fiber chemists are being supplied daily with more and cheaper raw materials. What is the chance that they will produce superior fibers out of them?

In discussing this situation, let us suppose that for some good reasons a chemist or a company has decided to use a certain chemical material, such as cellulose acetate or nylon. Is there still a chance left to vary the mechanical properties of fibers, films or molded pieces of such a given material and hereby maintaining the opportunity at least to a certain degree, to adjust the properties of the final samples to some given specifications? Experience has, in fact, shown that out of the same polymeric material, samples with very different mechanical properties can be made depending upon the *state of order* in which the long chain molecules are brought in the course of the various processing steps, such as spinning, casting, drawing, extruding, molding, etc. We are faced here with an *organic chemical metallurgy* and *metallography* in which the characteristic physical features of the *condensed state* are *superimposed* over the *fundamental chemical properties* of the raw material. Therefore, the question arises: Do we know what connections exist between the principle structural features of a given polymer and the mechanical properties of samples made from it? Such knowledge, if it exists, obviously would be of great value in designing polymers for special purposes and in greatly improving the properties of the ultimate products. A fair answer to this question seems to be that we do not have a well-developed mathematical theory which connects quantitatively the structure of a given polymer with mechanical properties of samples made from it, but we do know a number of general rules and principles which correlate properties and structure and which have been helpful in many cases in obtaining materials of superior quality.

There are, as already mentioned, two main factors that influence the ultimate behavior of a polymeric material (1) the chemical nature and the structural details of the long chain molecules themselves; and (ii) the way in which these molecules are arranged in the final sample. The same distinction can also be expressed in a somewhat briefer form in terms of (i) the *chemical structure* of the polymer molecules and (ii) the *physical texture* of the macroscopic sample. We shall now attempt microscopic sample. We shall now attempt to discuss these two factors in order.

* Presented at Fundamental Research Session, Silver Jubilee Convention, December 13, 1946.

TABLE I

Molecular Weights and Degrees of Polymerization of Some Representative Polymers

Material	*Elements*	*Molecular weight*	*Degree of polymerization*
Cellulose in native cotton	C, H, O	ca. 1,600,000	ca. 10,000
Cellulose in wood pulp	C, H, O	ca. 500,000	ca. 3,000
Cellulose in rayon	C, H, O	80,000-160,000	500-1000
Cellulose acetate in rayon	C, H, O	80,000-140,000	300- 500
Cellulose acetate in film	C, H, O	100,000-160,000	400- 600
Native rubber	C, H	200,000-400,000	3000-6000
Buna-S	C, H	100,000-150,000	1500-2000
Polyvinyl chloride (Geon)	C, H, Cl	100,000-200,000	1500-3000
Polyvinylidene chloride (Saran)	C, H, Cl	100,000-300,000	1000-3000
Polyvinyl chloride acetate (vinylite)	C, H, O, Cl	100,000-200,000	1500-3000
Polystyrene	C, H	100,000-300,000	1000-3000
Polymethylmethacrylate (Lucite)	C, H, O	100,000-200,000	800-1600
Protoin in native silk	C, H, O, N	ca. 150,000	2500
Polyamides (Nylon)	C, H, O, N	ca. 25,000	250

Details of Chain Structure and Mechanical Properties of Polymers

Let us first enumerate the most important structural details of high polymer molecules and briefly report our present knowledge on their significance for the mechanical properties of polymers. There are, first of all, the average molecular weight and the average DP of the substance, which according to Table I, vary from 20,000 to 1,000,000 and from 100 to 5000, respectively. There is the molecular weight distribution, which describes the heterogeneity of the material and is comparatively narrow in some cases and fairly wide in others, and there is the internal flexibility of the individual chains, which is a consequence of the chemical nature of the bonds between the monomers.

The connection between mechanical properties and average DP has been frequently investigated. The general result is that, in order to obtain mechanical strength at all, a certain minimum DP which ranges between 40 and 80 is necessary. As soon as this critical value is exceeded, the material starts to exhibit mechanical strength and its ultimate tensile strength increases from now on continually with the average DP. Up to DP between 40 and 80 the tensile strength of a film cast from this material is negligible and it then increases about in proportion to the chain length. The proportionality between mechanical strength and DP holds up to a DP of about 250. After a DP of about 600 is reached, the mechanical properties depend but slightly upon DP.

While the influence of the average DP on the mechanical strength is fairly well established, the significance of the molecular weight distribution is still an unsolved problem. Promising attempts have been made recently to establish a connection between the distribution curve and the mechanical properties of high polymers; it is found that relatively small amounts (between 10 and 15 percent by weight) of constituents having a DP below 150 are detrimental for such mechanical properties as tensile strength, resistance to flexing, fatigue performance, and so forth. Removal of such constituents of low molecular weight improves the material considerably.

Let us next consider the internal flexibility of the individual molecules. It is a well-established fact that each atom in a small molecule carries out rapid vibrations, the energy of which represents the main part of the heat content of a solid (crystallized) material and can be studied by the molecular spectrum (ultraviolet, infrared, Raman) and the temperature dependence of the thermal capacity. In larger molecules, such as the polymers listed in Table 1, there exist in addition to these rapid vibrations of the individual atoms comparatively slow vibrational and rotational movements of certain parts or segments of a large molecule. This does not imply that the rotation about the single C - C bond is actually free. In fact, recent investigations have shown that, owing to the mutual interaction of the substituents, subsequent CH_2 groups in a long chain paraffin molecule cannot rotate freely about the connecting bond. However, vibrational movements within angles of about 10° are much less inhibited, and as a consequence a chain of many CH_2 groups — say a thousand or more — will exhibit as a whole a considerable degree of internal flexibility. There are no sharp bonds to be expected within the range of a few CH_2 groups, but the chain as a whole will be capable of assuming a large number of slightly curved or coiled geometric configurations, and the probability of finding such a large molecule in its most extended state is extremely small. If an isolated long chain molecule is brought into this state of extreme elongation by external forces (mechanical stretching), it has the tendency, under the influence of its random thermal motions, to return to the most probable configuration, which is characterized by a certain degree of folding and curling. This represents a tendency of the long chain to contract if it is once extended.

The rate at which it contracts, however, will not depend upon how much more probable the final (contracted) configuration is than the original (extended), but upon how fast the chainlike molecule can pass from the extended into the curled-up state, which in turn will depend upon how quickly the individual segments of the molecule can swing from one geometric position to another that is separated from the first by a certain energy barrier. Thus, the rate of contraction of a polymer is a matter of the rate of chain segment diffusion in the face of energy barriers that separate the possible positions of the individual chain segments from one another. In an isolated long chain molecule these barriers depend upon how much the free rotation about the consecutive bends in the chain is hindered, either by the intrinsic rigidity of the bend or by the mutual interaction of substituents. It must be added that in an actual piece of rubber there are no *isolated* chain molecules, but a condensed multitude of them in a state of irregular entanglement, attracting each other with intermolecular (van der Waals) forces. This mutual interaction also contributes to the hindrance of the free mobility of the individual molecules and their segments and hence affects the rate of contraction of the material.

There is another aspect of the hindered internal flexibility of the molecules in a polymer. The reason for this hindrance is the existence of energy barriers which have to be overcome as the segments move into less and less geometrically biased positions. Each elementary step of recovery, therefore, requires a certain activation energy, which is responsible for the influence of temperature on the rate of segment diffusion and hence on the rate of recovery. If the energy barriers over which the segments have to go are high, it will, at low temperature, become more and more difficult for an individual segment to acquire this energy and the rate of recovery will be considerably reduced. This means that the material will be slow in adapting itself (by segment movement) to the external stress, and hence it may develop brittleness.

Thus we may conclude that the intrinsic flexibility of the individual chains is of great importance for the mechanical characteristics of elastomers and affects mainly the rate of recovery from the extended state and its temperature dependence, particularly the point at which the material begins to exhibit brittleness.

It may be added here that the chemical nature of a given polymer is of great importance for its chemical reactivity, swelling, and solubility. Thus polyhydrocarbons, such as natural rubber, polystyrene, polyisobutylene, and so forth, are very resistant to acids and alkalis, and do not

absorb water, but eventually swell and dissolve in hydrocarbons and other typically organic solvents. Polymers containing many hydroxyl groups, such as cellulose or polyvinyl alcohol, are in turn very resistant to the action of organic solvents but absorb moisture and eventually even dissolve in water or in weak alkali. It seems, however, that the mechanical properties of polymers depend not so much upon whether the monomer is a hydrocarbon, an ester, a sugar, or an alcohol, but rather upon the chemical characteristics as embodied in the molecular chain structure and expressed by average DP, DP distribution and internal flexibility of the chain molecules. In fact, Table II shows that fairly strong fibers can be made from materials that are very different chemically.

After having now briefly discussed how the structural details of the individual chains affect the mechanical properties of a polymer, let us pass to the importance of the mutual arrangements of the chain molecules in a sample.

Arrangement of the Chain Molecules and Mechanical Properties of Polymers

It may be worth while to consider very briefly the behavior of an ordinary organic substance. At the freezing temperature a liquid of low molecular weight, such as benzene, toluene or isoprene, undergoes a very distinct change in mechanical properties within a narrow temperature range. Below the freezing temperature ordinary substances are crystalline solids; they respond to shearing stress by undergoing small (1 percent or less) predominantly reversible deformations and exhibit the long range order (100A or more) of a three-dimensional crystal lattice. Each molecule is held by attractive and repulsive forces of all surrounding particles in a relatively well-defined equilibrium position, about which it performs rapid, quasi-harmonic vibrations. Transition of an individual molecule from one equilibrium position to another (self-diffusion) is extremely infrequent, the average amplitude of the vibrations amounting only to about 5 percent of the distance between adjacent equilibrium positions. Such systems appear to us as rigid, hard substances, having a definite shape and all other characteristics of a solid body.

As the temperature is increased, the vibrations of the individual particles become more and more vigorous until, at the melting temperature, the forces between the constituents of the lattice can no longer maintain the long range order of the crystal, and the whole structure breaks down. The result is a liquid, characterized by the absence of any far-reaching geometric order. The nearest neighbors of any individual molecule, it is true, are arranged about the latter in much the same manner as in the crystalline state, but molecules a few Angstroms farther away are distributed practically at random. Each single particle, again, carries out rapid quasi-elastic vibrations about an equilibrium position; but this equilibrium position itself (being a position of minimum potential energy) is not fixed in its location and the molecule undergoes, in addition to vibrations, an irregular translational Brownian movement, which makes it change its place rather frequently — self-diffusion is rapid. The lack of long range order prevents a liquid from sustaining shear or stress and from assuming a definite shape; it flows. In recent year physicists have succeeded in giving a very satisfactory explanation of many important properties of liquids on the basis of this picture.

TABLE II

Comparison of the Various States in Which Ordinary Organic Substances Can Exist

State	*Extent of geometric order*	*Viscosity*
Crystalline	Long range (more than 1000 A)	High
Glassy	Short range (only a few A)	High
Liquid	Short range (only a few A)	Low

A liquid can be undercooled below its equilibrium melting temperature, thus retaining the characteristics of its disordered (amorphous) geometric structure. The coefficient of viscosity ν decreases with increasing temperature, roughly following an exponential relationship,

$$\nu = A \exp (B/T)$$

(where A and B are constants and T is the absolute temperature) and at a sufficiently low temperature the material becomes hard and brittle; it is then called a glass. The transition from rigid glass to viscous liquid frequently occurs in a relatively narrow temperature range (the softening point) with no sudden change in structure and with no discontinuity in the primary thermodynamic variables, such as heat content, free energy and specific volume. Thus in the case of ordinary (low molecular weight) organic substances, the relationship between the crystalline, glassy and liquid states can be represented by the scheme of Table II.

High polymers consisting of long chain molecules exhibit a more complicated behavior. The strong chemical bonds inside the individual chains are seldom, if ever, severed during the normal mechanical deformation of the polymer, such as stretching of rubber or spinning of nylon, or during the various thermal treatments, such as annealing or molding. The changes in shape which take place during these processes occur at the expense of opened (and reclosed) bonds between the individual chains, which are not due to chemical forces, but to the various types of intermolecular interaction, such as hydrogen bridges and van der Waals forces.

Let us, from this point of view, compare the crystal lattice of isoprene with that of stretched (or frozen) rubber and consider what happens if the temperature of both systems is increased. In frozen isoprene, each individual molecule (C_5H_{10}) is located in a definite equilibrium position, about which it undergoes irregular, quasi-harmonic vibrations. The distance between any one molecule and its next neighbor is about 4 to 5A, while the interatomic distances within the molecule are only 1.0 to 1.5A. This elucidates the fact that the C_5H_{10} molecule is held together by strong chemical bonds, having dissociation energies of 70 kcal/mole or more, so that it forms a well-defined unit in the lattice, while the forces between the molecules are of the much weaker, van der Waals type (about 5 to 8 kcal/mole). Nevertheless, below the melting temperature, the bonds between molecules suffice to maintain the long range order of a crystal lattice, and frozen isoprene is a hard, rigid substance. Above the melting temperature, however, all long range connections between the molecules disappear and the result is a liquid with rapid self-diffusion of the individual molecule and small coefficient of viscosity (about 10^{-2} poise).

In frozen rubber, each individual isoprene residue (C_5H_8) as well as each C and H atom within it, vitrates about a definite equilibrium position; but a thorough investigation of the lattice shows that each isoprene residue is particularly close to two other residues, indicating that long linear chains of residues exist, within which all next-neighbor distances correspond to strong chemical bonds. The main valence chains of isoprene extend parallel to the direction of the stress, have a length of several thousand monomers, and represent the backbone of the whole structure. In all directions perpendicular to the axes of the chains the distances between adjacent molecules are determined by normal van der Waals forces. This lattice, therefore, is highly anisotropic, with strong forces along the parallelized chains, and weak forces perpendicular to them. As the temperature is increased, the weak intermolecular bonds gradually are severed and thus the lateral arrangement of the chains is disturbed and eventually destroyed. The chains start rotating about their axes, changing their mutual distances and eventually curling

and coiling up in an irregular way. However, while the weak bonds between the individual chain molecules are opened, the strong (chemical) linkages within them remain unaffected. The molecules are not degraded at temperatures at which the lattice structure has already broken down. This has the important consequence that although the long range geometric order of the lattice disappears upon raising the temperature to the softening point, a long range entanglement due to the unaltered existence of the long chain molecules is maintained. This long range entanglement is responsible for the fact that, at the softening point of a polymer, we get not a liquid, but a rubbery solid.

An individual isoprene residue in (amorphous) unstretched rubber vibrates with about the same intensity as does an isoprene molecule at the same temperature in liquid isoprene, and it will also carry out about the same short range Brownian movement; but, owing to its position in the chain molecule, it will not be able to diffuse farther away from its original positions without affecting other parts of the chain to which it belongs. This geometric restriction of the various segments of the flexible linear macromolecules due to the strong bonds between them produces a long range entanglement, which enables the material to sustain moderate stesses of shears, hence to maintain a certain definite volume and shape and resist elastically any attempt of deformation. In this sense rubbers have a state between the solid and liquid, just as glasses do, and one may say that glasses are liquids with high viscosity, whereas rubbers are liquids with long range entanglement (see Table III). The self-diffusion of chain segments is not essentially affected by the long range entanglement and, therefore, is rapid, whereas any displacement of the large linear molecules as a whole, is impeded by their mutual interaction over long ranges and therefore is very slow. The irregular motion of portions of the chains under the influence of the temperature has been termed, by W. Kuhn internal, or micro-, Brownian movement; the displacement of the macromolecules as a whole is referred to as external, or macro-, Brownian movement.

Using these terms, we can say briefly (and with a certain degree of oversimplification) that rubbers are materials that have rapid internal but slow external Brownian movement. It is this combination that characterizes the rubbery state.

Significance of the Two Different Brownian Movements

Let us first consider for which essential feature of rubberiness the two types of Brownian or molecular motion are responsible. If we start stretching a rubber, we expect it to begin deforming at comparatively low stresses; it is supposed to be a soft, extensible material, having a small initial Young's modulus. For typical elastics (Isoft rubbers or gun stocks), Young's modulus is between 10^6 and 10^7 dyne/cm^2 (15 to 150 lb./in.^{2}). If a material is to extend appreciably under the influence of such small stresses, it needs a considerable degree of internal mobility, much like a normal liquid. In fact, rubbers have many properties in common with ordinary liquids. They possess a compressibility very similar to that of liquids. Poisson' ratio for all "soft" elastics is in the neighborhood of 0.50; the thermal expansivity of rubber is of the same order of magnitude as that of ordinary liquids, and (perhaps most surprising) the solubility of gases (hydrogen, oxygen, etc.) and solids (sulfur, selenium, etc.) in rubbers resembles rather closely the solubility of the same materials in ordinary liquids. The "local" fluidity of elastics produced by the fast internal Brownian motion is also responsible for this rapid contraction. In a stretched rubber certain segments of the individual chains assume configurations the free energy of which is larger than in the unstretched condition. Therefore, as soon as the external force ceases to act, these portions will start to diffuse back into their unstrained (equilibrium) positions, which correspond to a minimum free energy and represent the relaxed state of the sample. How quickly this contraction takes place depends upon the rate of segment diffusion, which determines the "local" fluidity of the material.

Certain materials "snap" back into their original shape, because segment motion is fast; others "creep" back, because the local mutual interaction of the chain segments is strong and prevents them from assuming their unstrained positions within a short time. Natural rubber, neoprene, Butyl-rubber and the Buna types are examples of the first case; polystyrene above 80°C, Vinylites and moist polyvinyl alcohol, of the other. In order to get a good, snappy elastic, one has to keep the internal Brownian motion as rapid as possible, which means that one has to accentuate the local liquid character of the system.

On the other hand, if we provide in an elastomer for nothing but this high local fluidity and keep a macroscopic sample of the material under stress for a certain length of time, the material will flow. It will not sustain the imposed stress or shear, but, with the very aid of the rapid internal Brownian motion, will relax into the extended state instead of into the contracted. Hence it will behave like a viscous liquid or plastic rather than like a rubber. To prevent this permanent loss of shape, one has to provide for strong long range entanglement, which makes the external Brownian movement (slipping of whole chains along one another) so slow that it cannot produce any appreciable permanent set within the time the sample is in its extended state. In general, the mutual attraction of the chain by van der Waals forces alone does not provide for a sufficiently stable long range entanglement to conform with practical requirements. Therefore, one usually produces a system of irregularly distributed, widely spaced fix points. They provide a stable, but highly deformable network throughout the sample, which can be stretched several hundred percent and will return to its original shape, because its individual knots are connected with one another by flexible chain molecules. Such fix points can be made in different ways. One way is to produce strictly localized, strong chemical bonds between the individual chains, such as sulfur, oxygen, or methylene bridges, as is presumably done during the various processes of curing and vulcanizing. Another way is to have groups of particularly strong molecular interaction (hydrogen bonds, strong dipoles, highly polarizable groups) or of great bulkiness (phenyl, benzyl or napthyl groups) randomly distributed along the chains, thus producing an irregular network of areas with high molecular adhesion. Still another method is to distribute very small particles with high absorption

TABLE III

Transition Points for Ordinary Substances and High Polymers

(a) Behavior of ordinary substances:

	Melting point	
Long range molecular order		Short range molecular order
No Brownian motion		Rapid Brownian motion
Sustains external forces; exhibits short range, high modulus elasticity		Does not sustain external forces; flows and has low visocity

(b) Behavior of polymers:

	Brittle point	Flow point	
	Solid state	Rubbery state	Liquid state
	Long range molecular order	Short range molecular order, but long range entanglement	Short range molecular order
	Both Brownian movements are frozen in	Internal Brownian motion rapid; external Brownian motion still frozen in	Both Brownian motions are activated
	Sustains external forces; exhibits short range, high modulus elasticity	Sustains external forces; exhibits long range, low modulus elasticity	Does not sustain external forces; flows and has medium viscosity

power (active fillers) in the polymer, which provide for fix points by absorbing parts of the mobile chains irreversibly on their active surfaces.

In all these cases, the localized and infrequent strong links between the individual flexible chains suppress the external Brownian movement sufficiently to prevent permanent flow of the sample as a whole, while they leave the internal Brownian movement sufficiently unaffected to allow rapid extension and contraction to be possible.

This discussion shows that a polymer can exist not in two but in three condensed states; the solid, the rubbery and the liquid. In the solid state (crystal or glass) both Brownian movements are frozen in; in the rubbery state the internal Brownian motion is activated while the external Brownian movement is still frozen in; and finally, in the liquid state of the polymer (in the melt or in a highly swollen sample) both Brownian movements are activated. Under the influence of an external force the solid state has only short range, high modulus elasticity, the rubbery state has long range, low modulus elasticity and the liquid state provides for flow. An ordinary organic substance has only two condensed states, the solid and the liquid; there exists only one type of Brownian motion, which is activated in the latter and frozen in the former state. These two phases, solid and liquid, are in equilibrium with each other at the freezing (or melting) temperature. In the case of polymers there are two characteristic temperatures (or temperature ranges); the brittle temperature, which separates the solid from the rubbery state, and the flow temperature, which separates the latter from the liquid.

Considering the facts as discussed in the preceding section, it becomes clear that, in order to produce a polymer for practical purposes, one has to synthesize chain molecules with a DP around 1000, having a certain degree of internal flexibility. This material has then to be brought into the proper physical state or mixture of states. And here we realize that we have at our disposal three different phases; the solid, the rubbery and the liquid. The task of bringing the polymer into the best physical state is similar to that of a metallurgist, who attempts to find the best properties of his alloy in the phase diagram of his system, with the difference that this organic chemical "metallurgy" puts one more state at his disposal, namely, the rubbery. This is because of the presence of the long chain molecules.

It is now obvious that, if the desire is to produce a strong and resilient fiber, one will have to accentuate the solid state in order to get stiffness and tenacity and will have to provide for only as much rubberiness as will give a sufficient resiliency. Any liquid constituent in such a fiber would be unwelcome because of the permanent set to which it leads under prolonged external stress. If one aims at the production of a typical rubber, it will be necessary to have the bulk of the material in the rubbery state, with perhaps some crystalline domains in order to provide for a sufficiently strong fix-point system. Finally, in producing a plastic, one will have to provide for an appropriate mixture of solid and liquid material with as little rubberiness as possible in order to guarantee smooth extruding, casting or molding without recovery after the desired shape has been obtained.

In this sense it can be said that fibers, plastics and rubbers are not intrinsically different materials: they are merely different combinations of three fundamental states in which organic high polymers can appear; and there exists, obviously, a continuous range of systems, starting with extreme fiber properties and ending with extreme rubber qualities, depending essentially upon the degree to which the solid, rubbery and liquid state are represented in the sample.

Hence, there are two independent ways to arrive at new polymers with novel and interesting mechanical properties: (i) to prepare chemically new monomers and produce long chain molecules of them with a high DP and a favorable molecular weight distribution, and (ii) to bring these substances into the proper physical state by adjusting the proportions of the solid, rubbery and liquid constituents such that they incorporate to the best degree the desired properties. Along both lines a large number of research chemists and physicists are active, and there can be little doubt that their work will lead to an ever-increasing number of new materials with valuable and surprising properties.

Discussion

Mr. Fine: Is it possible to simulate the molecular weight distribution curve of natural rubber, and if one could do that, would the elastic properties of such a polymer be equal to that of natural rubber?

Dr. Mark: I think the answer should be yes to both questions. As it was indicated in the first slide, we are in a fairly good position to estimate the influence of the *average molecular weight* on mechanical properties of a polymer. However, we do not yet know too much about the importance of the shape of the molecular weight distribution curve on the mechanical properties. We know they depend upon it, but we don't know exactly how. It seems probable that if we simulate the distribution curve of natural rubber we will get a material with more similar mechanical properties. I think this is a very interesting point.

Mr. Fine: Do synthetic rubbers give X-ray patterns?

Dr. Mark: There are synthetic rubbers which do show distinct x-ray patterns, such as Neoprene and polyisobutylene, whereas others such as GR-S or Hycar OR do not. The order necessary to produce relatively sharp points of a fiber diagram is rather high and not all synthetic rubbers give such highly ordered structures after stretching. Whenever the chains of a synthetic rubber possess a sufficiently simple structure, it shows the phenomena of crystallization, just as natural rubber does.

* * * *

Chairman Schwarz: If there are no other questions, we want to express, on behalf of the Association, our deep thanks and appreciation to Drs. Harris, Siu and Mark for their contributions this morning, and for the follow-up which will come in the published papers later on. I think you will agree with me that the technical session, from the standpoint of the fundamental research treatment, has been highly successful. We appreciate your coming and the very definite degree of attention that has been paid to this morning's program.

CALENDAR

NEW YORK SECTION

Outing: June 20. (North Jersey Country Club).

PHILADELPHIA SECTION

Meetings: September 26, November 8, January 16, 1948, February 27, 1948, April 9, 1948, May 21, 1948 (Bellevue-Stratford Hotel, Philadelphia.)

NORTHERN NEW ENGLAND SECTION

Meetings: September 26, November 21.

PIEDMONT SECTION

Outing: June 20 and 21. (Ocean Forest Hotel, Myrtle Beach, S. C.)

MID-WEST SECTION

Outing: June 21 (Lake Lawn, Delavan, Wis.)

NATIONAL CONVENTION

October 23, 24, 25. (Congress Hotel, Chicago, Ill.)

Plastic Film Printing*

RALPH A. NELSON
Velveray Corporation

OUT of the reservoir of human ideas has emerged a new creation—plastic film. Plastic film with its unique qualities of serviceability has a definite place in our mode of living and can render a service to the consumer which is different and modern.

Two Types of Film

When speaking of film, I have in mind two types, supported and unsupported plastic films. An unsupported film is one which is all plastic and varies from .004 inches to .050 inches in thickness. The .004 inch gauge is the most popular film and is used in most of the articles which will be mentioned later. The heavy gauge film .020 inches and upwards, is used for upholstery, handbags, shoes, etc. A supported film is one which has a backing, usually a textile fabric or paper; the film thickness for these supported films runs between .002″ to .025″.

Two Methods of Decoration

Although many types of plastics are used in the manufacture of plastic film, the most widely used type is the vinyls. These are mostly made by a calendering process. Films are also cast, or made by coating from solutions or melted plastics, and extruded. Some are cured such as the thermo setting type, while others are the thermo plastic type which set on cooling. The supported films are decorated in two ways:

(1) Printing of the fabric before applying the plastic.

(2) Printing on the plastic after it has been applied to the fabric or paper backing.

The former can be accomplished with the conventional textile printing methods while the latter is printed with a different end use in mind.

Uses of Films

Much speculation has been made as to whether or not this new plastic film will replace the conventional textile fabric which has served for so many centuries. My answer is a qualified "yes." For many purposes, its usages such as shower curtains, garment bags, raincoats, and umbrellas, to mention only a few will definitely give greater satisfaction because of their basic relation to the end uses. Plastic film, as far as the consumer is concerned, is more than just resin and plasticizer. It becomes more or less associated with fabric and is, therefore, compared with it. As in textiles, therefore, styling and distinctive fashion appeal must play the same important role in its use and serviceability.

The development of printing on textiles has given impetus to greater consumption by the consumer by reason of its decorative style appeal. By the same reasoning, printing must become even more important with respect to plastic film. It must be remembered that in the field of textiles, elements other than printing such as variations in yarns and different weaves make their decorative appeal. With respect to film, we believe that printing must be substituted for these additional style elements.

Printing on Film

The art of printing on film is entirely new. We have found that many new techniques and changes from ordinary types of textile printing had to be evolved in order to do a satisfactory print job. Our long experience in the textile printing field points to an analogous condition between that field and film printing. Years ago, when the rayon industry first started to manufacture fabrics made from acetate yarns, great difficulty was encountered because the science of dyeing and printing acetate fabrics had not kept abreast with the manufacture of the fabric itself. In many cases, good cloth was poorly dyed or printed because of lack of knowledge on their part. However, research in printing coupled with the cooperation the industry received from the fabric manufacturer, eventually solved all the problems satisfactorily. Similarly, with respect to film printing, much pioneer development has been and still is continually taking place. We have designed and built special machinery and are in constant touch with the makers of film.

We have found that the greatest difficulty that confronts the film printer is the fact that the chemical components of the film vary so greatly. It is not at all unusual for the printer to find that after he has developed an ink that will give satisfactory results for a particular formulation, that his problem is not solved at all because the manufacturer of the film, through necessity, has changed at least one of the film components. The net result is that the print job is not the same from one lot to the next. Until this condition has become stabilized, the film printer will not be able to give a uniformly satisfactory result unless he keeps in constant touch with the makers of the film and is frequently informed by them of any changes in their formulations.

Control Tests

Many laboratory control tests of the film, both before and after printing, are necessary to insure first quality prints. The following are a few of the tests used: abrasion test, utilizing the Taber Abraser and also the Wyzenbeck Abrasion machine, soap solution tests, the Fade-Ometer test, a tack test, which demonstrates the degree of tackiness of the film in the roll both before and after printing. The printed film is tested by the use of a Crockmeter to determine the degree to which the print will crock. Many other tests are also used. It is necessary to follow the principles of testing continually in order to insure the highest quality of chemical bond between the print and the plastic film.

Multi-Color Patterns

We have learned that there is a vast difference in printing single color on film as compared with the printing of multicolor patterns on film. Inks, which when printed by themselves on a particular film, give satisfactory results, will not be found successful when used in conjunction with other inks. One of the reasons for this is that an ink may be so slow in drying that when used in a multicolor pattern, it will lick off or contaminate the ink in the second row. On the other hand, used by itself, it may be satisfactory. We have tried to shorten the

* Presented at meeting, New York Section, May 2, 1947.

drying period of such an ink on the theory that it should be dried before it hits the second roller. In order to do this, we must change the formula of the ink. Changing the formula gives us a different result, particularly where adhesion is concerned. Although a certain volume of multi-color film has been printed satisfactorily, it must be recognized that a very high degree of skill is required and that the problem of multi-color printing on film has by no means been completely solved.

Mechanical Difficulties

In addition to inherent chemical difficulties found in the printing of vinyl film, particularly light gauge, we have encountered many mechanical difficulties. The inks used in printing vinyl film require heat to dry them, as well as the re-formulations described previously. Heat, of course, tends to soften film. If the film gets soft, it must be handled with extreme care or blocking or marking off of the printed pattern result. Therefore, after printing and going through the dryers, the temperature of the film must be lowered in order to make it possible to be handled. Various methods are used to lower the temperature of the film or to cool it at this point.

Another obstacle in the printing of film has resulted from the fact that many of the films brought into the market were made on calenders unsuitable for that purpose. The result was that the calender roll had a crown that caused the film to belly. This belly caused distortion in the printed pattern and also caused great difficulty in winding on to batch rolls. Progress is being made to eliminate this objection, and today we receive film from a number of sources which lies flat.

The fact that vinyl film is elastic makes proper register difficult in printing multi-color patterns. An extremely high degree of skill is required to print multi-color patterns, control the elasticity, and get good commercial register between the various colors.

Our greatest problem in printing vinyl film has been caused by so-called plasticizer migration. Where this occurs, the ink blocks off on the back of the film that it touches. If the film is transparent, the blocking off shows through on the face making the print imperfect. Because of the variations that have existed and to a large extent continue to exist in this respect, the printer has found it necessary to wind paper between the layers of the printed film as the only sure way to prevent blocking off.

We have been carrying on intensive research in order to eliminate this inter-leafing operation. It is needless expense added to the cost of the film and in some markets, paper inter-leafing is definitely objectionable. We have already found that we can print film, dry the finished product and at this point, three months from printing, we still have discovered no blocking off. Of course, we are not satisfied that a three month period is sufficient to establish it as being successful, because we must expect that department stores will keep goods in stock for much longer periods than three months. We are continuing on tests and hope that within the near future we will be able to offer a printed film to the market which will not require inter-leafing.

The problem of printing polyethylene film has not as yet been completely solved. However, we have done much work on this product and at present have been able to develop an acceptable printing job on this type of film although it is by no means up to the high standard attained in the printing of vinyl films.

Types of Inks Used

With regard to the inks used in plastic printing, there are three types used:

(1) Inks which after applied, leave the film immediately available for fabrication with no after treatment of the film necessary.

(2) Inks which after printing on the plastic film, will be embossed producing grained effects.

(3) Inks which after printing on the plastic film, will be press polished producing a glossy surface.

I have various samples of the finished printed plastic films here to demonstrate these three types.

At this stage of the development of film printing, we cannot honestly say that we can do on film all that has been achieved on textile fabrics; we know that the possibilities for decorating on film are unlimited. Although the child is lusty and shows signs of precocious growth, it is not yet an adult and must still be given time to grow up.

Illumination for Textile Color Matching*

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Background

IT is the purpose of this paper to briefly summarize the background, procedure, and part of the results of a study which began informally and which later grew to such an extent that it was adopted as an Inter-Society Color Council problem.** The study started as the result of a discussion of experiences in connection with the color temperature and level of illumination used in textile color matching.

During this informal discussion an investigation was described of color temperature and level of illumination of color matching lamps used in a certain large mill. It was reported that the lamps varied from 4,000°K to 10,000°K. This explained the frequent conflicts over shade matches.

The many complaints from textile mills regarding the quality of North light were pointed out. Generally, these complaints were similar—shades which appeared to match under North light at one mill were sometimes rejected when examined under North light at other plants.

Reference was also made to studies conducted in the Department of Agriculture. It was brought to the attention of the group that these studies suggested that a minimum color temperature of 7500°K be employed for color grading of agricultural products and that a minimum intensity of between 60 and 80 foot candles be maintained.

The American Association of Textile Chemists and Colorists' specification for standard illuminants in textile color matching was discussed. This specification recommended two standards for color temperature, the I.C.I. Illuminants A and C, 2850°K and 6750°K respectively, with a minimum of 60 to 80 foot candles for light shades and a minimum of 150 foot candles for dark shades.

* Presented at meeting, Northern New England Section, March 21, 1947.

** I.S.C.C. Problem No. 13, the Subcommittee on which included C. Monego, Julius Forstmann & Co., Inc.; P. M. Otto, Jr., Botany Worsted Mills; F. T. Simon, Sidney Blumenthal & Co.; Capt. S. Backer, Philadelphia Quartermaster Depot; E. I. Stearns, Calco Chemical Div.; N. Macbeth, Macbeth Daylighting Corp.; I. H. Godlove. General Aniline; J. J. Hanlon, U. S. Navy; Dorothy Nickerson, U. S. Department of Agric.; Frank J. O'Neil, Pacific Mills (affiliations are those in effect at time of study).

However, it seemed evident to the group that there were many points not covered in any of these studies.

It was suggested that a program be arranged by which answers could be obtained on the following questions.

1. What color temperature of natural daylight is used by textile color matchers?

2. What color temperature of artificial daylight is preferred by textile color matchers?

Equipment

Certain pieces of equipment were procured for this work. An Ansco-Sweet Densitometer was obtained which had been altered to measure color temperature. A Weston foot candle meter was used for measurements of level of illumination.

A special lamp unit was assembled with allowance for five color temperature changes from 6750°K to 13,500°K.

Dyed textile samples were provided for inspection under the various illuminants. These included five series—red wool cloth, yellow cotton cloth, blue spun viscose cloth, brown wool yarn and black viscose rayon pile velvet cloth.

Trials

The equipment was used intermittently throughout the year 1944. Measurements of the quality and quantity of natural daylight were made at the Forstmann Passaic plant from January 3 to February 4, and, at the Garfield plant, from February 7 to 29 and March 9 to 31; at Botany, from April 24 to June 16; and at Pacific, from August 24 to October 10 and from December 11 to January 2.

While these records of natural daylight were being obtained, approximately 90 individuals connected with some phase of color matching in each mill examined the five groups of textile samples under six conditions of artificial daylight and also under natural daylight on a particular day of their own choosing. The six conditions of artificial daylight were filtered Macbeth illumination at 6750°K, 7500°K, 8400°K, 10,300°K, 13,500°K and daylight fluorescent illumination. The participants recorded color differences in paired samples under each light and, at the end of the test, selected their artificial light preference.

Results

Results of the study presented a considerable amount of very interesting data. However, only certain points concerning the quality and quantity of illumination will be mentioned here.

In regard to natural daylight used by textile color matchers it was found that the color temperature varied from 5000°K to 30,000°K and the intensity varied from 20 to 500 foot candles (on the basis of over 1000 measurements). Color temperatures were higher in winter, lower in summer; foot candles were lower in winter and higher in summer. Color temperatures showed no periodic variation with time of day while foot candles changed regularly.

It was also found that the color temperatures of north daylight from a slightly overcast sky occurred chiefly in the 6000°K to 12,000°K range—a variation of 6000°K. This fact is interesting because slightly overcast sky is regarded by the majority of colorists as the satisfactory sky condition under which all controversial matching should be done. The foot candles of slightly overcast sky occurred in the 100 to 400 foot candle range.

Natural daylight conditions called "Very Good" averaged 224 foot candles at 9400°K for clear sky; 211 foot candles at 8850°K for slightly overcast sky; 332 foot candles at 6500°K for overcast sky. Slightly overcast sky—averaging 8850°K at 211 foot candles—was the preferred sky condition in 77 percent of the cases called "Very Good."

In regard to the color temperature of artificial daylight preferred by textile color matchers, 7500°K was the choice of 41% of those replying. 6750°K was next, comprising 27% of the replies.

It was also found that the color temperature under which the shades of the textile samples were compared most accurately was 8400° K, although this color temperature was but slightly better than 7500° K, the illuminant which gave results most closely corresponding to those obtained under natural daylight.

A Study of Manipulated Blends*

ALEX. MORRISON

Chief Chemist, American Woolen Co., Shawsheen Village, Mass.

BY Manipulated Blends we mean blends that are composed of wool and/or reprocessed wool and/or reused wool combined with cotton and/or rayons and/or other fibers, synthetic or natural.

There are some people who believe that if a fabric is to be finished so as to contain 60% wool and 40% rayon on analysis all one has to do is to lay down a blend in this proportion and your finished fabric will contain these amounts of these two fibers.

There are others who know more about the business, who when they lay lown a blend make allowances for amount of moisture and grease or oil in the two fibers they are using and lay down their blend in proportion of 60% clean dry wool and 40% clean dry rayon. In very rare instances will the blend so corrected give them the resultant fabric with the 60% wool 40% rayon clean fiber content.

Lend Lease Fabric

We had occasion to manufacture in one of our woolen mills a Lend Lease fabric to contain not over 40% rayon and incidental vegetable matter. Our analysis on oven dried clean fiber basis of the finished fabric showed varying results on different pieces running from a high 44.65% rayon to a low of 41.09%, using a 5% correction for loss of rayon in caustic boil.

Investigation disclosed the blend as laid down was:

35% Rayon

45% Wool (Carbonized Fine Burr Wastes)

20% of 2 Reused Wools, one a Carded Coarse DK. Merino and the other a Carded Peralta rolled Pastel.

Were there large amounts of grease and oil or vegetable matter in the reused stocks or differences in moisture content of the various fibers that accounted for the results in the finished fabric, or was our correction factor on the rayon too far out of line when we consider they only put in 35% rayon?

Testing of Stocks

While we were reasonably sure of what was happening we had to go through a series of tests to prove it. We first tested all the stocks used in making the fabric. (See Table I).

It is to be noted that the average

* Presented at meeting, Northern New England Section, March 21, 1947.

TABLE I

	% Grease	% Moisture	Determined % Correction Factor for Loss in Caustic Sol'n.
Dull Cut Staple Rayon	0.08	9.0	3.37
Viscose Garnet	0.33	0.68	4.23
Dull Viscose Rayon	0.55	9.5	5.70
Average	0.32	9.39	4.43

	% Grease	% Moisture	% Caustic Residue Arbitrary 3% Correction Factor for loss of Vegetable Matter in Caustic Sol'n.
No. 1 Carbonized Burr Waste	1.04	10.0	0.2
No. 2 Carbonized Burr Waste	0.8	10.13	0.97
No. 3 Carbonized Burr Waste	0.82	9.35	0.99
Average	0.89	9.35	0.72
Carded Dk. Merinos	12.7	8.0	2.86*
Carded Peralta Pastel	10.96	8.83	6.09*
Average	11.83	8.42	4.48*

*4% Correction as Residue was Cotton and some Rayon.

TABLE II

	Clean Dry Rayon or Veg. Matter	Clean Dry Wool
35 lbs. Rayon—Av. Grease 0.32 Av. Moisture 9.39	31.60	
45 lbs. Wool (Burr Wastes) Av. Grease 0.89 Av. Moisture 9.83 Av. Veg. Matter 0.72	Lost	39.852
20 lbs. Reused Wool Av. Grease 11.83 Av. Moisture 8.42 Av. Veg. Matter 4.48	.896	15.054
	32.496	54.906

$$\% \text{ Rayon \& Vegetable Matter } \frac{32.496}{87.402} \times 100 = 37.18$$

TABLE III

	Caustic Residue Test 1	Test 2
Card Strip 1st Breaker Veg. Matter & Rayon 4% correction	11.83	14.8
Card Strip 2nd Breaker Rayon 5% correction	11.35	14.9
Card Strip Finisher Rayon 5% correction	15.05	15.1
Card Waste Brest Rayon 5% correction	9.54	19.6
Card Waste 1st Breaker Rayon 5% correction	15.77	11.9
Card Waste 2nd Breaker Rayon 5% correction	12.51	12.0
Card Waste Finisher Rayon 5% correction	18.86	14.7
Warp Yarn Rayon 5% correction	37.49	39.3
Filling Yarn Rayon 5% correction	38.87	36.9
Av. Warp & Filling	38.18	38.1
Fabric off Loom Rayon 5% correction	38.46	38.1
Finished Fabric Rayon 5% correction	40.73	41.1

All results average of two tests.

noisture contents of the three stocks, rayon 9.39%, burr waste 9.83%, and reused wools 8.42%, were not too widely spread, so that not taking these into consideration when weighing out the blend wouldn't account for results we found on the finished cloth.

The average correction factor on the three rayon stocks was 4.43% for loss of rayon in the caustic boil. We had used an arbitrary 5%, but in a fabric supposed to contain 40% rayon this 0.57% too high factor would mean our results were only 0.23% too high and the discrepancies on the finished cloth were running from 1.09 to 4.65% too high.

The average 0.72% caustic boil out residue in the burr wastes was partially carbonized vegetable matter and would be lost in the cards.

In fairness to the mill management I will say that in laying down blends for this fabric they didn't use all three rayons, all three burr wastes or both reused wools. The rayons and burr waste lots were changed from day to day depending on stocks on hand, and the reused wools were changed depending on whether the pieces were to be dyed light or dark shades. Generally speaking there was not too much difference in the determinations on the stocks of each class.

If we take the blend as laid down and assuming we used all the stocks and correct each stock for the average grease, moisture and caustic residue to an oven dried clean basis, we arrive at a proportion of rayon and wool which one might believe were in the finished fabric. (See Table II).

But our fabrics were averaging considerably above 40%.

Caustic Residue Determinations

In the meantime we had collected two sets of samples from 2 blends of all the different card wastes, warp and filling yarns, fabric off the loom containing these yarns, and finished headings from the same loom pieces and made oven dried caustic boil off residue determinations on the oven dried clean stock, yarn or piece basis. (See Table III.)

This set of figures proved our suspicions. Please bear in mind that the blend was laid down with 35% of rayon by weight. You will note all these card wastes run from a low of 9.5 to a high of 18.8% rayon which means we were losing considerably more wool fiber in our wastes than rayon and, therefore, the amount of rayon was building up so that in the yarns we had more than our 35%. I am not certain but I think the warp and filling yarns were the same size and there must have been pretty close to the same number of ends and picks since you will note that our average results on the warp and filling yarns check pretty closely with the results on the pieces off the loom.

You will note on one finished piece we found an increase in rayon content over that in piece from loom of 2.27% and on the other 3.0%. That is, there was a loss of wool fiber in fulling, scouring and shearing.

If we had known the weights of these various wastes, and weights and content of spinning wastes, calculations could have been made to check the rayon content of yarns.

This investigation proved that in laying down a blend for a manipulated fabric, while it is well to make allowances for moisture and grease contents, allow-

(Concluded on Page P334)

A New Approach to Coated Fabrics*

DAVID S. PLUMB

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FABRICS destined for water-proof coatings have been an important market for the textile industry since the first "India Rubber" was painted on a piece of cotton and made into a poncho about 120 years ago in New York City. This first product antedated even the work of Charles Goodyear and was one of the first important commercial uses of rubber. Since those early days, the yardage of such fabrics, the diversity of the types of materials used for coatings and the end uses to which the finished products have been put have increased astronomically.

The importance of coated fabrics to manufacturers of textiles is readily testified to by the following approximate figures.

In 1946 about 100 million yards of fabric were coated with rubber, about 100 million yards were coated with nitro cellulose and about 40 million yards with oils or alkyds.

1946 also saw extensive coating of fabrics with the newer vinyl plastics. Exact yardage figures are difficult to obtain, but the Department of Commerce figures show about 12 million pounds of vinyl resins on a resin basis were used for coating. This represents 25 million lbs. of coating compounds, and if an average coating weight of around 6 oz. per square yard is assumed, the yardage is estimated to be at least 65 million. There was then, in 1946, a consumption of somewhere around 300 to 350 million yards of fabric accounted for by the coating industry.

Types of Fabrics

In the main, what were the types of fabrics used to make up this large yardage? Generally, they were plain white bleached sheetings of various counts and weights, plain white sateens, drills and twills, lightweight ducks and canvas. The end uses for the coatings were widely diversified. They were made into raincoats, oilcloth, shoe fabrics, upholstery fabrics, handbag fabrics, book covers, hospital sheeting, baby pants, closet accessories, nursery goods, window shades, railroad fabrics, insulating materials and many other related products. Generally speaking, with the exception of some integrated activities dictated by the circumstances of price control, this yardage was all marketed through the conventional time-honored channels in use for coated fabrics for many years.

The major marketing effort was made after the fabrics were out of the hands of the textile industry itself.

It is only recently with the advent of the newer plastics for fabric coating that an opportunity has presented itself to the textile industry to use coating as a fundamental and integral part of the usual finishing operations. It is only with this development that styling and high-powered promotional selling have become part of the coating process, and the marketing of some types of coated fabric has become a function of the textile industry itself.

The reason for this more direct interest in coated fabrics is that the new coating imparts all of the functions expected from a coating without impairing the appearance of the uncoated fabric. In most cases, too, the hand of the fabric has not been harmfully affected, although it is still impossible to prevent the presence of some plastic feel after coating. Thus, a new approach to the coating industry has been made possible.

Classes of Vinyl Resins

There are three general classes of vinyl resins now serving this industry. The first two, vinyl chloride and copolymers of vinyl chloride can be grouped together as they are similar in appearance, processing techniques and properties. Their development in the coating industry so far is tending to follow the conventional lines of mere substitution of material in a given type of product. For example, they have been widely used in the manufacture of artificial leather for upholstery. Nitro-cellulose has been a major supplier of this market, and the vinyls offer far reduced fire hazard and greatly improved flexibility, durability and age resistance with very little sacrifice of price. A small quantity of these resins is being used as a clear coating over printed or otherwise decorated fabrics which tends to approach textile finishing and marketing methods, but the major use so far appears to have been limited to the nursery trade. It is probable that the third class of vinyls, the vinyl butyral, is the most important new coating of the transparent type and the one which most readily lends itself to textile styling and marketing.

Vinyl butyral is little known to the average layman, possibly because it has never been widely promoted by means of a trade name. It should, however, be very familiar as practically every automobile built in the last 12 years has used a vinyl butyral flexible film as the interlayer in the safety glass sandwich. When rubber was cut off in 1942, butyral was first used as a textile coating, and in the ensuing 3 years about 26,000 miles of fabric were coated with it and used in army raincoats, ponchos, water bags and flotation gear. It has only been in the last year, however, that those properties of butyral which make it excellent for safety glass have been combined with its use as a textile coating.

Properties Imparted by Coating

There are only two important properties imparted to a textile by coating—water-proofness and resistance to staining. If these two properties can be given to a decorated fabric without noticeably affecting the appearance or feel, a multitude of new markets is opened up. For example, consider the common household product, the tablecloth. The tablecloth market for generations has been divided into three groups—the high-priced linen and damask dinner cloths, the printed cottons and rayons which are much cheaper and last of all oilcloth which seldom gets beyond the kitchen table. Consider the convenience and the saving in laundry bills if all of the functional properties of oilcloth could be obtained on the dining room table with all the style of a printed cotton or rayon and conversely if the same style could be utilized in the kitchen without sacrifice of the oilcloth function.

With this thought in mind, a lightweight cotton sheeting was screen printed with an attractive design and then coated wih three base coats of a clear, flexible vinyl butyral compound followed with two top coats of a similar compound containing finely divided silica to remove the gloss and tack. The finished coating

* Presented at meeting, New York Section, May 2, 1947.

was dry to the touch and sufficiently matted to be practically invisible. It had a hydrostatic strength of about 50 lbs. per square inch in the Mullen Tester and 50 centimeters of water in the Suter Tester. It did not look coated, yet ink or ketchup could be spilled on it and easily wiped off with a damp rag.

This cloth was tested by the Bureau of Standards of a large New York department store and after being found satisfactory was put on sale at a price considerably higher than the same cloth would command uncoated. The sale was backed by a moderate amount of advertising, and in short order the first lot of 800 dozen was disposed of, and a similar product is now a standard item in that store's line.

Following this initial experiment, the same type of coating was applied to many more fabrics destined for household use. In addition to tablecloths, slip cover fabrics, drapery and upholstery fabrics are being coated. More specifically, textiles destined for bedspreads, outdoor and porch furniture, and of major importance, even standard living room slip covers, upholstery and drapery are using butyral as a coating.

Equipment

The coating is applied on the standard coating equipment of either the rubber or nitro-cellulose type. Most of the coatings are light in weight and are applied by a knife-spreader. The plastic is soluble in ethyl alcohol and is handled like a rubber or pyroxylin lacquer. The number of coats applied varies with the machine and the fabric, but an average of 3 or 4 is usually sufficient. The top coat necessary to provide the gloss-free surface is then applied on the same machine. The total coating weight is around 1½ oz. per square yard on an average sheeting or drill. After coating, the fabric is exposed to hot dry air usually at a temperature of 260° F. for 30 minutes, but faster techniques are also possible. This final treatment causes a thermosetting reaction which is analogous physically to the vulcanization of rubber and which increases adhesion to the fabric as well as solvent and heat resistance of the coating.

Testing Properties

A coating of this weight is practically invisible and usually gives a characteristic hand to the fabric. The clothy surface is left practically intact, and the fabric frequently feels as if it had been starched. Coating quality is controlled by a hydrostatic test, and a Mullen of 25 lbs. per square inch is usually set as minimum. The coating has excellent flexibility and good flex fatigue life withstanding 10,000 sharp flexes and creases without noticeable failure. Weathering age and oxidation resistance of the plastic itself are excellent. 100 hours in a Weather-Ometer, 140 hours in a sun lamp, 100 hours in a Fade-Ometer, oxygen bomb tests and finally 180 sun hours (about 2 months) of outdoor exposure in Florida all failed to harm it. The coated fabric can be laundered using a mild laundering technique and ironed, the iron being on the uncoated side. Since the whole idea of the coating is to avoid laundering, this factor is not important but desirable.

The stain-resistance of such a coating is completely satisfactory for normal household use. Most foodstuffs, ink, dust and perspiration can be removed with water or, if necessary, by scrubbing with a detergent. Some foodstuffs, notably mustard, ink from ball point pens and shoe polish are known to be difficult or impossible to remove if left on the coating very long. In many cases, however, these stains tend to bleach out in light. Stain-resistance has been very difficult to evaluate as test results are seldom reproducible. Apparently with any vinyl resin stain-resistance is a function of the plasticizer content, the smoothness of the surface and, of course, absence of pin holes in the coating. It is believed that with adequate and informative labeling any vinyl coating is sufficiently stain-resistant for practical household use.

Heat-resistance is no problem as the curing process eliminates all thermoplasticity. Hot pots from the stove have no affect, and the coating will not block under a 24 hour test at 300° F. When the butyral coating fails, its failure is almost always caused by loss of plasticizer with consequent stiffening. Thus, prolonged exposure to heat, high alkalinity in soaps, boiling water, many solvents and severe weathering all cause some stiffening from plasticizer loss. The flexibility at which the product is considered usable is the limiting factor in resistance to these agents. Dry cleaning is particularly severe in removing plastizer, and standard laundering with alkaline soap has a similar result.

Colors Used

There are a number of problems involved in the application of butyral clear coatings to decorative fabrics. First of these is colors used for dyeing or printing the fabric. Prints fail either by bleeding caused by the solvents in the coating solution or by a tendency to mark off when two coatings are placed face to face. The latter failure is far more common than bleeding and is probably caused by a tendency for the dyestuffs to dissolve in the plasticizer and to seek equilibrium in concentration when placed adjacent to another coated surface. Extensive work has been done to overcome this difficulty. Vat dyes are usually satisfactory, although many reds will mark off. Algosol colors are usually satisfactory, but many of the Rapidogens fail completely. Chrome colors have been fairly good. There seems to be little rhyme or reason to the test results on all the various dyestuffs, and each dye should be tested at least once before being assumed satisfactory. Thorough washing of the printed fabric before coating is also advisable.

Weight of Coating

The second problem is the choice of weight of coating. The ideal coated fabric has the absolute minimum of coating on it coincident with satisfactory performance. The higher the fabric count, the lighter the weight which will give a uniform coating. An average figure of 1½ oz. per square yard on tablecloths and indoor upholstery fabrics can be used. For continuous outdoor exposure, however, it has been difficult to ascertain the minimum coating weight satisfactory. A 1½ oz. coating can conceivably leave a coating thickness of less than ½ mil above the yarns, and it is asking a great deal of any material to withstand constant exposure to sun and rain as well as normal wear in such a minimum thickness. It is probable that for continuous outdoor usage a coating weight between 2 and 3 oz. should be recommended. For the usual porch furniture, the 1½ oz. coating should be satisfactory and will impart stain-resistance as well as resistance to rain. Continuous unprotected outdoor exposure requires not only the heavier coating for durability but upholstery which is fabricated to be water-proof in all respects.

Selection of Fabric

A third problem is the selection of fabric. Most of the work has been done on cotton, but there is no reason why viscose rayon, nylon, Fiberglass or wool cannot be used. The flatter the fabric surface and the tighter the weave, the easier it is to obtain water-proofness. Fabrics containing considerable texture can be coated by calendering, but equipment is not available which will lay down a film by calendering below about 3 oz. per square yard in weight. A new process is being developed which is based on laminating a film cast on paper to a fabric which will allow the coating of open weaves and quite deep textures. Pile fabrics are, of course, not coatable.

The future of coated textiles of this type is in the hands of the textile industry

itself rather than in the hands of the plastic manufacturer or processor. A great deal of prejudice built up over many years against the use of a coated fabric for household purposes must be overcome. It is certain that there is no better time than the present when industry in general enters a buyer's market, and the consumer becomes quality conscious to expand the production of a product offering so many functional advantages with such a minimum of utilitarian appearance. The manufacturers and marketers of textiles have thus been presented with a new approach to the old and tremendous field of coated fabrics by the advent of these new plastics.

Discussion

Question: Does the fact that you add the film to, say, your tablecloth, affect the flammability in any way?

Mr. Plumb: It, of course, depends entirely on the resins you are using. Talking on the subject of vinyl butyral it hardly has any effect whatsoever. It burns about the same rate as cotton. If you use vinyl chloride compositions, and I don't know any of them that would be suitable for tablecloths, of course, it can retard the burning rate.

Question: Are they the coatings applied in solution or emulsion?

Mr. Plumb: Both. Actually all the production experience of which I know has been entirely from solution.

There is a latex of vinyl butyral and a latex of vinyl chloride. The butyral latex applies a film without heating other than simply removing the water. The vinyl chloride latex requires a rather high heat, flash cure, to coalesce it in a finished film. There is no reason why with the proper equipment latex could not be used. It just so happens that I don't believe anybody has gotten around to that as yet.

Question: What is the percent of solution in alcohol?

Mr. Plumb: Thirty-five per cent in transparent materials.

Question: If the resin is soluble in alcohol, how is it resistant in the tablecloth to that same alcohol?

Mr. Plumb: That is a very good question. The heart of the development that has taken place in the last six years with vinyl butyral has been the development of a method of vulcanizing, which I pointed out is analogous physically to vulcanizing rubber. Chemically, I believe it is a condensation, although the work we did to find out what the nature of the chemical reaction was has not been successful, but we believe it is condensation. The material is then insoluble in alcohol. Constant exposure to alcohol removes the plasticizer with consequent stiffening, but the contact with alcohol encountered in homes is just low enough not to be damaging to any extent whatever.

Question: The vinyl butyral solution is made in two classifications. One is non-curing and the other is fast-curing. Can you tell us the difference in these?

Mr. Plumb: Yes. There is very little fundamental difference in non-curing material and fast-curing. The non-curing material is usually not recommended.

The vinyl butyral composition commonly used contains a high proportion of plasticizer. That means that if it is not cured it is extremely thermoplastic. It would soften at a very low temperature, say 120 degrees or something like that. Therefore, we would not recommend for the average household use a thermoplastic non-cured material. By variation in pH of the solution you can vary the curing rate.

Most of the production experience with this type of coating has come through the rubber industry which is naturally equipped for vulcanizing. We have been fairly cautious in going from the prolonged heat cures to the very rapid cures which can be done in less than a minute with exposure to 300 degrees or for longer periods at lower temperatures.

From all indications, a fast cure material of that type is practically equivalent in all respects now to the high heat cured.

Question: Is there any definite information as to resistance of the vinyls to constant immersion in sea water?

Mr. Plumb: I know of no definite information. The presence of salts in the water usually lessens the harmful effects of water. I don't know why, but the absorption of salt water is lower than the absorption of fresh water. I would suspect that in any material using an ester plasticizer or a fatty-acid plasticizer, constant exposure over a long period of time will remove the plasticizer with consequent increase in stiffness. I cannot give you any exact information.

Question: You spoke of markoff or bleeding of the dyes when you folded one layer of film against another. Have you had any experience with pigment colors?

Mr. Plumb: We have had very little experience with pigment colors. We have made one experimental run on pigment colors. The trouble with pigment colors—I am not talking as a dyestuff man now, so don't hold this against me—as I understand, pigments are bound with resinous materials themselves. We have found that in the case of that one run there was a tendency for the coating not to adhere where there was a high amount of resinous binder with the pigment. I think that could be worked out, and we do have some plans for working on it. If it can be worked out, the coating should absolutely prevent the normal crocking of pigment colors, but I think we will have to wait until we have done more work on it.

Question: With reference to the statement you made regarding the saponification of the plasticizer, does that apply to all known plasticizers?

Mr. Plumb: I was thinking of the liquid plasticizers such as the fatty-acid and esters.

Question: What equipment would be used for milling?

Mr. Plumb: Well, any plant that is equipped to handle nitrocellulose, or any plant equipped to handle rubber, can start with vinyl butyral, from scratch and make practically any compound they want to make. The most experienced production methods have probably been gained in the rubber industry where they simply take a slab of plastic and put it on the rubber and mill the pigments in.

In the nitrocellulose plants I think the easiest thing to do is to make a fairly dilute solution of the compound. That can then be ground in a paint mill or pebble mill with the pigments with a standard technique using a dilute solution of the plastic itself as a vehicle. There is not enough plasticizer in most cases to have the plasticizer itself be used as a vehicle.

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Manipulated Blends—

(Concluded from Page P331)

ances also have to be made for possible different proportional losses of the fibers in processing not only in carding anl possibly spinning but in finishing. These proportional losses will vary greatly with the physical character of the stocks used.

Quite possibly if the rayon and wools were about same staple and possibly diameter, losses as appeared in this fabric would not have resulted. But in woolen fabrics generally, the rayon is the longer staple and thus does not tend to be in as high a proportion as the wool fibers in the wastes. Of course, in this particular fabric the burr waste was of comparatively short staple and thus was lost in larger proportions in the wastes. Mill superintendents who are responsible for making up blends for manipulatel fabrics to certain specifications can be guided only by experience with various combinations of stocks or on a continued cut and try process until they get the balance required and even then they may find some variations in the finished fabric from blend to blend.

ABSTRACTS FROM CONTEMPORARY JOURNALS

The Fault Was in the Dyeing

"Kemmek", Textile Mercury and Argus, page 229, Vol. CXVI, No. 3020, February 7, 1947.

Curing faults that occur in the dyehouse are of utmost importance to the dyer. Although the fault may occur in dyeing its cause may be found in some other stage of the manufacturing process.

A resultant cloudy dyeing obtained when using acid colors on improperly washed-out soap-milled pieces may be rectified by treatment with alkali and solvent.

Listing may be corrected by bagging the faulty piece, boiling in sulfuric acid and re-dyeing to shade.

If a stained piece cannot be re-dyed a darker shade it is best to strip, neutralize and re-dye to shade. Nitrate of iron stains occurring in burl dyeing, may be removed by stripping with ammonia and boiling with sulfuric acid. Burl re-dyeing back to shade is then possible.

Radiant Energy Reflectance of Men's Wear Colors

Helen F. Greenler and Frank J. O'Neil, Textile Research Journal, page 63, Vol. XVII, No. 2, February, 1947.

An investigation of the radiant energy reflectance characteristics of men's wear colors on worsted fabrics was made. The term "radiant energy" includes the infrared, the visible, and the ultraviolet regions of the sun's spectrum with most of the energy equally divided between the visible and the infrared regions. Previous investigations show that the increase in the heat of the sun's rays in summer is due largely to its increase in energy in the visible part of the radiant spectrum. Visible energy is equally important as infrared energy when determining the heat reflection of fabrics.

The investigation included spectrophotometric measurements made in the visible and near infrared regions. The nearest Munsell notations describing the colors tested are given along with average visible and infrared reflectance values and radiant-energy reflectances. Light colors exhibited greater radiant energy reflectance than the medium or dark colors. To select between two or more colors which appear equally light or equally dark, consideration should be given to their infrared characteristics which will indicate the more desirable shade.

Depth of shade has a direct effect on the transmittance of radiant energy by a fabric. A darker shade is more absorbent and decreases the amount of energy transmitted, however a point is reached in the darker colors beyond which the advantage is lost due to the higher absorption of radiant energy.

A practical application is described, the results of which support the data reported in the paper.

The Role of the Supervisor in Scientific Management

P. C. Singal, The Indian Textile Journal, page 217, Vol. LVII, No. 675, December, 1946.

There are nine main duties listed that a supervisor must perform properly in order to attain a good job of supervision. Most supervisory personnel are either not qualified or do not have the time to perform all of these duties and therefore functional management may be used. Functional management divides the work of management so that each man concentrates on one or two leading functions.

The supervisor must know the work to be done and should have knowledge and ability above the workmen under his supervision. He must plan the work so as to have a busy department. Careful attention should be made to equipment as well as inspection of work for quality. The supervisor should get the best possible results from the workers and in this regard the foreman himself should be very active. In order to know his progress he should keep in constant touch with production records.

An example of a supervisor's time apportionment in a cotton mill is given. The essentials of the proper selection of supervisors is summarized.

Copies of Journals Abstracted will be loaned upon request

Application of Phase Microscopy to Textile Fiber Rsearch

H. Reumuth, Textile Research Journal, page 69, Vol. XVII, No. 2, February, 1947.

This paper is summarized as follows:

The phase method of microscopy affords many advantages in the observation of the fine structure of fibers over the normal microscope and the electron microscope methods.

The fine detail of thin cross-sections of wool fibers may be observed by this method without the specimen preparation of swelling and staining. The phase microscope allows mycological studies on textiles without bacteriological staining.

Important observations of thickening pastes used in printing fabrics have been made. When examining materials of this nature the true perspective and structural characteristics are shown with the phase microscope.

Liquid-crystal systems of natural and artificial soaps and lubricants can be more thoroughly examined with the phase technique. Solid crystals are also very favorable subjects for the phase microscope. A detailed description of the advantageous use of the phase method is given.

Examination of synthetic fibers from regenerated cellulose revealed no homogeneity in the fiber. The usual observation with bright-field illumination would not indicate this conditon.

Surface defects on synthetic fibers due to successive launderings are clearly shown with the phase microscope. The location of silica particles imbedded in the fibers by laundering with detergents containing silicates is accurately determined by phase microscopy. Fissures and fiber strain caused by laundering are readily apparent.

Limitations are encountered with the use of the phase microscope. Failure is to be expected in the observation of very thick objects. Poor detail of the pigments in crushed cupra staple fibers delustered during the spinning process is noted.

Comparative photomicrographs using the phase technique and the normal light-field method are included.

• PATENT DIGEST •

PAUL WENGRAF

Shrinkproofing Wool — Vinyl or Butadiene Polymers A, 2, 04

French Pat. 911,855
(Montclair Research Corp., July 23, 1946)
(According to "Teintex" December 1946 page 373)

Wool and wool containing fabrics are rendered shrinkproof by treating them in an aqueous bath containing a synthetic butadiëne polymer or a co-polymer of butadiene and vinylite and the like. The final textile material must contain 1-25% of this polymer. A formula is given in this French abstract consisting of butadiene, methylmethacrylate and a stabilizing solution buffered at a pH=10 and not particularly described. Hydrogen peroxide and laurylsulfate of sodium are added as emulsifying agents.

References: Shrinkproofing wool material has been described in U. S. Pat. 2,406,412 (Imp. Chem. Ind.) issued in the meantime on Aug. 27, 1946: the fibers were exposed to vapors of vinylidene compounds. Styrene compounds can also be used as shrinkproofing agents when combined with iodine (see U. S. Pat. 2,406,958, du Pont, issued on Sept. 3, 1946). Polyvinylresins have shrinkproofing properties according to Brit. P. 575,264 (Dunlop Rubber).

Drying Apparatus for Textile Fabrics G, 3

Canadian Pat. 438,681
(United Merchants & Manufact. Inc., Paul and Fred Miller, December 17, 1946)

(Preliminary Remark: Canad. Patents are, as is well known, not open for public inspection. This abstract was kindly made available to me by the company to which the invention was assigned.)

A drying apparatus is protected which may be used either for drying the fabrics in motion or moving from one stage to another. The fabric (58) is first momentarily exposed to a source of radiant heat (Blocks 2 and 3), sufficiently concentrated to volatilize a substantial portion of the water in the fabric without impairing the material. Drying is then completed by a relatively prolonged exposure of the fabric to heated gases or vapors, for example hot combustion gases which may be mixed with steam. This part of the drying process is accomplished by conveying the fabric through a series of serpentine passageways (23). This part of the drying chamber contains also means for generating and re-circulating combustion gases shown in the drawing at (33), outlet at (46). The way of the combustion gases circulating around the walls of the passageways (23) can clearly be seen in the drawing.

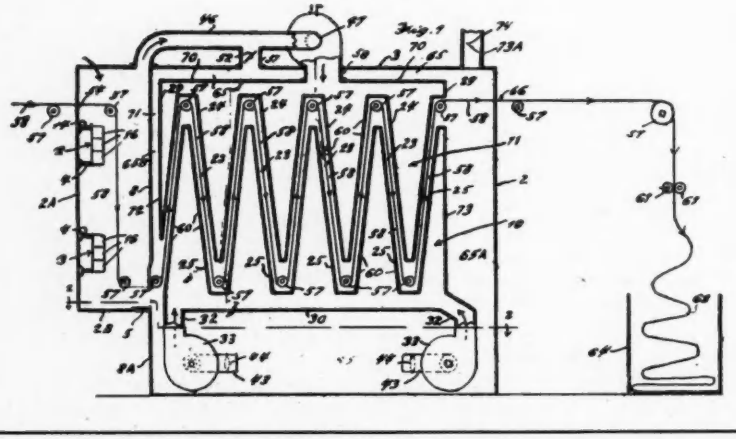
Viscose Yarns — Coated With Rubber G, 2, 02

French Pat. 913,230
(Courtaulds Ltd., September 2nd, 1946)
(According to "Teintex" December 1946, page 373)

This invention relates to rubberized textiles which may be used as waterproof materials. The adhesion of rubber to viscose rayon is improved by adding proteins such as casein in proportions between 0.5-2%, calculated on the cellulose content of the viscose. This protein content is said to improve at the same time the stability of the filaments against the prolonged action of temperatures up to 130° C, acting this way probably as protective colloid.

References: Mixed filaments, prepared from rubber latex and viscose to which gelatine, glue or casein are added in order to decrease their extensibility are described in Shepherd's Brit. P. 447,972 and 449,314. Generally protein solutions are added to viscose dopes in order to increase the fiber's affinity to acid dyestuffs (compare French Pat. 781,268, I. G. Farben Ind.)

Drying Apparatus



Preventing Tendering of vat dyed fabrics on Light exposure C, 4, 02

Brit. P. 582,143 (Soc. Chem. Ind., Basel) according to the "Dyer" Jan. 3, 1947 p. 29

Fabrics dyed with certain vat dyestuffs, especially with orange or yellow brands are known to be tendered upon exposure to light. The present patent claims to find a simple solution of this problem by impregnating the fabric with a water soluble precondensate of formaldehyde and a nitrogen-compound containing the group $-C(=NH)-N=$ and no elements of a higher molecular weight than 16. The ratio of C to O has to be smaller than that present in urea: thus urea itself is excluded. The specification mentions for instance as an example for the nitrogen component dicyandiamidine which is reacted with formaldehyde to form a thick paste. This paste is stirred into water and formic acid is added. Cotton fabric dyed with a yellow vat dyestuff is impregnated with this solution and may or may not be cured thereafter. The tensile strength of the goods is after a sunlight exposure of two summer months:

Non treated material: 18% of the original tensile strength.

Treated material: 65.5% of the original tensile strength.

References: The Journal of the Soc. of Dyers & Col., Nov. 1945 p. 278 (Brea and Turner) and April 1946 p. 10 (Atherton & Turner) discussed this problem by investigating the possible reactions in the tendering phenomenon. It can very probably be explained by an intermediate peroxide formation on each quinone group. The Ger. P. 644,06 (Brit. P. 461,752) I. G.-Storb-Ott, assumes that the damage results from a frequent change of oxidizing and reducing reactions (which might be an identical explanation to that offered in the above

named articles). Tendering of vat dyes can be prevented according to this invention by adding substances which are able to slow down the oxidizing reaction. The Ger. Pat. mentions in first range quinones, hydroquinone and so on, the Brit. P., otherwise parallel to the German Patent, recommends also tannine. The present invention is the more surprising because quite generally *urea*-formaldehydes have been proposed for different after-treatments of dyeings while explicitly the urea-condensates are excluded in the present process.

Starch Esters G, 2, 01

U. S. Pat. 2,412,213 (M. G. Groen, 12/10/1946)

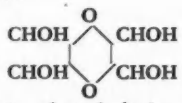
Several methods for the production of fatty acid esters and particularly of acetic acid esters of starch have been proposed. Up to now however, it has not been possible to obtain a sufficient degree of esterification. This reaction would proceed more readily according to old experience by bringing the starch into a soluble or gelatinized form. It has already been recommended to subject starch first to a swelling action by treating it with chloro-acetic acid or to solubilize it by heating the product in a glycerine suspension at 160° C. but in all the known processes degradation of starch goes too far for giving valuable esters. According to the present invention it is possible to obtain highly esterified starches which are in some respects similar to those of cellulose and therefore *suitable for permanent coatings*, finishes and the like. The method consists of dispersing or dissolving starch in an anhydrous medium and treating it here in the presence of acetates with acetic anhydride (or with other acid salts and the corresponding anhydrides.) One of the examples teaches to saturate first acetic anhydride with dry ammonia gas. A mixture of ammonium acetate and acetamide results. Dry potato starch is dissolved in this liquid and the liquid is heated at 140° C. After adding some more acetic anhydride and distilling off the reaction's water a *water insoluble starch acetate* having between 2.5 to 7.5 acetyl groups is formed. Instead of potato starch the so-called cold-swelling starch can be used.

References: In the meantime U. S. Pat. 2,405,973, 1946 (Hamilton-Nichols) has been published suggesting to prepare alkylated starch which is solvent-soluble for coating purposes. U. S. Pat. 2,399,455 (Treadway) proposes to acetylate starch directly by suspending starch in acetic anhydride and to precipitate the ester by adding some water. Both patents are assigned from Hamilton to the Secretary of Agriculture. See also the article of Hamilton's in *Industrial and Engineering Chemistry*, Ind. Ed. August 1946 p. 864. Higher fatty esters of starch have already been described in Ger. P. 484,242, 1923 and in U. S. Pat. 1,651,366, 1923 by Berthou.

Shrinkproofing Cellulosic fabrics (Compare Abstract to U. S. Pat. 2,409,894) G. 20, 4

U. S. P. 2,412,832 (Cluett Peabody & Co., Pfeffer-Epelberg—Dec. 17, 1946)

Shrinkproofing cellulosic textiles has been performed according to different methods, either by mechanical or by chemical means. The treatment, described in the "Sanforizing" patents, belongs to the first group. The other group comprises generally a treatment with resin finishes by using pre-condensates in a carefully checked concentration, different from that used in creaseproofing processes. The present method is an improvement over a former patent assigned by one of the inventors (Epelberg) to the same company. This earlier patent suggested to use glyoxal as a shrinkproofing and creaseproofing agent which proved to be superior to other similar compounds in that there can be used less concentrated solutions compared with other crease-or shrinkproofing reagents. So for instance a concentration of 0.6—4.65% glyoxal has the same effect as a 6-8% urea-formaldehyde solution for stabilizing and a 14-16% solution for creaseproofing purposes. Moreover glyoxal does not emit disagreeable fumes during the curing operation as other products do. It is assumed that glyoxal: CHO is transformed in aqueous solution into CHO tetrahydrodioxane:



and re-transformed into glyoxal during the drying process upon the fiber. It has now been observed—according to this new patent—that still better results can be obtained by admixing some aminoaldehyde condensates to the glyoxal solution. An example for the finishing bath is a composition, containing about 20 g. glyoxal (in an aqueous solution), 3 g. oxalic acid and 45 g. of a water dispersible urea-formaldehyde pre-condensate, known in the trade as "Beckamine P-364" of Reichholds Chem. Co.

References: See the article written by one of the inventors (Epelberg) in AMERICAN DYESTUFF REPORTER, July 15, 1946, page 343. Shrinkage control carried out by a formaldehyde-urea resin treatment see Bener, U. S. Pat. 2,121,006, 1938, Rohm & Haas, U. S. Pat. 2,329,651.

Hair Keratin Solutions for Finishes, etc. G, 2, 01

U. S. P. 2,413,983 (Lawrence R. Bruce, Lustig-Kondritzer, January 7, 1947)

Up to the present time solutions of keratin, the basic material of hair and wool, have been obtained by an alkaline treatment, for instance by alkaline reacting sulfides or by alkali thioglycollates. The alkalies themselves are known to have a damaging effect on the protein molecule and the same is true for the alkaline reacting sulfides and thioglycollates. The inventors found that solutions prepared in this way and dialyzed thereupon settle out and the keratin becomes insoluble. According to the present invention a permanently soluble keratin derivative is prepared by introducing some acid radicles into the molecule. By working in this way the substance brought in solution with thioglycollates was found to be resistant to alkalies, to hard water and even to acids. The thus pretreated keratin shows a high molecular weight (about 25,000) and it is said to remain in solution after re-oxidizing the protein-SH-groups, opened by the solubilizing agent. An example suggests to treat hair at 0° C. with concentrated sulfuric acid for about 24 hours. After completely removing the surplus acid the product can be dissolved by thioglycollic acid at a pH of 9, the protein remains in solution after removing the solubilizing alkali and the excess of thioglycollic acid. After dialyzing, precipitation can be attained by bringing the pH down below 5, for instance by adding acetic acid.

Although the specification contemplates primarily a method for forming fibers from such a keratin dispersion it is possible that these solutions can as well be used for finishing purposes.

Reference: According to U. S. P. 2,337,220 (Ciba Co.) thioglycollic acid can be used as a product for permanently fixing hair at room temperature, thus for cold waving human hair. According to the present invention the thioglycollic acid has the surprising effect however to dissolve keratin after a pretreatment with acids which may have far reaching consequences in finishing operations as well as in spinning keratin fibers.

Pectin and other hydrophilic powders—Preparing G, 1

U. S. Pat. 2,412.282 (Essential Oil Producers—Nelson—Dec. 10, 1946) (Application 3/21/1944)

The present invention has the object to produce a free flowing, highly water dispersible pectin (or similar substances) which may be used for different indus-

trial purposes, amongst others also for finishing and thickening printing pastes. A spray-dried pectin is extracted with alcohol and the residue is then suspended in ethanol to which a higher fatty acid such as stearic acid is added. When the pectin is subsequently dried the stearic acid forms a thin film on each pectin particle, giving them temporarily water repellent properties. These little particles form a slurry when poured into water because of this small water repellent layer. Otherwise when no fatty acid is present—the particles have the tendency to swell rapidly, to agglomerate and to form jelly-like masses which no more readily disperse. It has to be stated however that this water repellent effect lasts only for a very short time and that dissolution takes place thereupon when a sufficient amount of water is added.

References concerning the use of pectin in general: Pectin has been used as a sizing agent—see *Mell. Textilberichte* 1944, p. 306 (Walter)—and for preparing thickeners—for instance U. S. P. 2, 392,854 (Mutual Citrus Prod.) During the war detergents have also been manufactured in Germany from alkaline pectin compounds according to Ger. P. 739,694 (Fischer) reported in *Chem. Abstr.* 1945 p. 4344. Brit. P. 476,778, 1937 (Pfeifer & Langen) describes a method for producing pectin for sizing and dressing purposes: finely divided beets are subjected to a lixiviation process with water at temperatures between 30 and 80° C, preferably at 50-55° C. The last bath has to contain some sulfur dioxide. A further treatment with steam in an autoclave gives a syrupy mass, which has to be evaporated to dryness.

Schiff-Bases—for rendering fabrics water repellent G, 2, 02

U. S. Pat. 2,413,024 (Sun Chemical Corp., Zerner-Davies-Pollak, Dec. 24, 1946)

The invention relates to improvements in the technique of "hydrophobing" fibers. Different processes have been patented in this field, the best known being the "Zelan" method, based on the reaction of cellulose with solutions of octadecylmethoxy-pyridinium chloride and similar products in a baking process. The inventors have now observed that organic compounds, known under the name of *"Schiff-Bases"* are also well suitable for making fibers water repellent under certain conditions. Schiff-Bases are quite generally condensates of aromatic amines with aldehydes or ketones. But the present process claims only the reaction's products with *ketones* containing higher aliphatic chains (C_8—C_{20}). Bases of that kind have been prepared for instance from heptadecylketone and aniline, naphthylamine or dodecylamine. An example is the compound

$C_{17}H_{35}$ > C : $NC_{10}H_7$ (di-heptadecyl-beta naphtylamine-anil).
$C_{17}H_{35}$ >

This substance is dissolved in Stoddard solvent. A cotton cloth is impregnated with a 1% solution. It did not show any repellency after drying but it became strongly water repellent after baking at 150° C. The spray-rating was under this condition 100% and dropped after dry-cleaning and laundering only to 80%.

References: The invention is a new step in the series of methods for making textiles water repellent by a treatment with substituted nitrogen bases. Brit. P. 467,166 (I. G. Farbenind.) suggested to treat textiles with higher amine salts (stearylamine acetate) in admixture with formaldehyde and other amines. It is assumed that in this event a condensate is formed while at the same time the fatty radicle links to the cellulose molecule. The present invention has the advantage to use bases, stable at room temperature and very reactive at higher (baking) temperatures.

Schiff-Bases have otherwise been used for manufacturing artificial resins, see Kolloidzeitschrift 1942, p. 361 (acc. *Chem. Abstr.* 1944 p. 3384), as Insecticides (Brit. P. 538,528, Allen & Sons) and as stabilizers for petroleum products (U. S. P. 2,282,513, du Pont).

Protein Condensates as flameproofing agents C, 2, 03

U. S. Pat. 2,413,163 (du Pont, O. C. Bacon, Dec. 24, 1946)

Among the many flameproofing agents the chlorinated paraffins or other chlorine-containing organic compounds have proved most efficient. Unfortunately—as it is disclosed in the present patent—hydrochloric acid develops not only at higher temperatures (which reaction is very essential in extinguishing flames) but also in the cold, especially under the influence of light. It is the purpose of the present invention to find a compound which might counteract this deleterious action of hydrochloric acid and to use on the other hand the chlorinated organic substances as before. In U. S. Patents 2,262,770 and 2,262,771 reaction products of formaldehyde and urea containing formaldehyde—caseinate have been described. These products are completely water dispersible and act as binding agents for flameproofing ingredients such as antimony oxide or chlorinated paraffin wax. The amount of formaldehyde is sufficient to react first with casein and later on with the urea contained in the composition. Although this condensate does not form an insoluble resin it is termed in the specification as "protein—resin—" reaction product. The formula of a flameproofing coating composition is:

Protein-resin reaction product	15.5 p.
Sb_2O_3	20.5 p.
Chlorinated paraffin wax	43.5 p.
Water	20.5 p.

A stable dispersion giving a permanent flameproofing effect was obtained by working this mixture in a high-speed-mixer.

References: Protein-formaldehyde condensates give by themselves only permanent but no flameproof finishes: see U. S. P. 2,380,020 (Brother Smith); Chlorine-containing condensates—phenol—formaldehyde—as flameproofing agents: U. S. P. 1,046,137 (Aylesworth).

Improving Fastness of direct dyeings—substituted adipamides C, 4, 01

U. S. Pat. 2,416,884 (du Pont, Schreiber-Schroeder, March 4, 1947, applic. Sept. 9, 1942)

The invention has the purpose of improving quite generally the *fastness of direct dyeings,* for instance that of water-soluble direct azo dyes. Many attempts have been made to solve this problem. The specification quotes for instance U. S. Pat. 2,169,546, 1939. (Ciba-Company—Use of Melamine-Aldehyde condensates for this purpose). Different processes deal with the application of resin condensates. It has been found that for instance melamine-formaldehyde condensates give quite satisfactory results but that these treatments endanger the texile material when complete curing of the resin is attempted. The present invention suggests to use instead *nitrocompounds,* containing at least two N-atoms, each of which is attached to a CH_2-group which in turn is connected by an ether oxygen to a hydrocarbon chain. A typical example is N-N′- bis (methoxy-methyl -) adipamide $CO-(CH_2)_4-CO$

$CH_3-OCH_2-N.H$ $H.N.CH_2OCH_3$

applied in form of a 20% solution and used for impregnating various fabrics dyed with direct dyestuffs. The solution has a pH between 3 and 6.5. The goods are dried and baked at temperatures between 120 and 170° C. for a short time. Other aftertreating agents are bis-methoxy- methylolurea, methoxy-methyl succinamide etc. Numerous examples are given.

References: By heating di-or polycarboxylic acids with mixtures of 1-2- or 1-1- diamines such as ethylene diamine aftertreating agents for direct dyeings are obtained according to U. S. P. 2,194,419 (I. G. Farbenind.). These products are different from the condensates described here above because of the formation of an amidine ring.

TRADE NOTES • NEW PRODUCTS

• New Salesmen, Textile Resin Dept., American Cyanamid

R. E. Sumner, manager of American Cyanamid Company's Textile Resin Department, announced recently that in order to meet the increasing demand of textile mills for information in regard to the new chemical finishes for textiles, two new sales representatives have been appointed. J. J. Derrig will be active in New York State, Long Island, Western Connecticut and Northern New Jersey. J. C. Clausi's assignments also include Northern New Jersey and metropolitan New York. Both men will make their headquarters in Bound Brook.

Mr. Derring and Mr. Clausi both have been associated with the technical staff of ACC's Textile Resin Application Laboratories. They are thoroughly acquainted with the theoretical and practical problems involved in the application of Lanaset resin for wool shrinkage control, Sheerset, Aerotex Softener H, and the many other Aerotex series of chemical finishes.

R. H. Drucker, who formerly had his headquarters in Bound Brook, has been assigned to the Pennsylvania, West Virginia and Virginia area with headquarters in Philadelphia.

• Heyden Chemical Production

Monochlorbenzene and allied products are now in production at the new Memphis plant of the Heyden Chemical Corporation, it has been announced.

The present limited production is spoken for, officials said, but added that monochlorbenzene, mixed higher chlorinated benzenes and muriatic acid will all be available shortly for general sale. The monochlorbenzene, which will be sold as such, is a base for DDT.

This will be in addition to the chlorine, liquid caustic soda and hydrogen with which the plant began operations late last year, although much of the chlorine output is now being utilized at the plant for the production of the chlorinated benzol products.

The plant uses an electrolytic process for the production of chlorine from the base raw material, which is rock salt, and the chlorine, with the addition of a catalyst, is passed through benzol and separated to obtain the newly announced products.

Although this is Heyden's initial production of chlorinated benzol products, the company has long specialized in chlorinations and produces a larger number of chlorinated toluol products at its Fords, N. J. plant.

• Solvay Booklet on Nitrosyl Chloride

The Solvay Process Company has announced a new booklet on Nitrosyl Chloride which will be of value to individuals or organizations interested or engaged in research. In addition to chemical and physical properties, this booklet describes the new all nickel cylinders and fittings which have been developed for storing and shipping nitrosyl chloride, gives information on handling laboratory preparation, safety measures and typical industrial applications. Also included are charts, sketches, a bibliography and patent references designed to assist technical and research men responsible for new chemical developments. Among the possible indicated industrial applications are its use in making wool non-shrinkable and making dye intermediates. Copies may be obtained by writing to The Solvay Process Company, Product Development Section, 40 Rector Street, New York 6, New York, and asking for booklet NC No. 1.

• New Booklet on Glycols

"Glycols" is the newest booklet in the group series published by Carbide and Carbon Chemicals Corporation, a Unit of Union Carbide and Carbon Corporation. It presents in detail the properties, specifications, and uses, of ethylene glycol, diethylene glycol, "Kromfax" solvent (thiodiglycol), triethylene glycol, propylene glycol, and ethylhexanediol. Some of the more important uses for the glycols are as hygroscopic agents; as liquid coolants for aircraft engines; anti-freezes for brewery cooling systems; as solvents for dyes, printing inks, essential oils, gums, and resins; and for the production of the nitrate esters in low-freezing dynamites. In 30 charts it gives such information as physical constants, comparative evaporation rates, and solubility data. It also includes 94 literature references to the glycols.

Copies of this booklet may be obtained from any Office of Carbide and Carbon Chemicals Corporation. When requesting your copy, ask for Form 4763.

• Molten Metal for Dyeing

Said to be perfected in England, a colloidal dye-stuff requiring pressure and temperatures below 212° F. to impregnate fabric, employs molten metal in an unusual manner.

The dye material is said to be forced into the fabric by passing the fabric down through the dye liquor and molten Cerrobend to the necessary depth to impart the required pressure. The dye liquor floats on the surface of the liquid Cerrobend. This metal does not stick to the fabric.

Machinery for this process is already in production.

Cerrobend, an alloy melting at 158° F, is manufactured by Cerro de Pasco Copper Corporation, Department ADR, 40 Wall Street, New York 5, N. Y.

• Monsanto Promotions

Dr. Lester A. Pratt, general sales manager of Monsanto Chemical Company's Merrimac Division has been appointed assistant to the division general manager, the company has announced.

Division General Manager Josiah B. Rutter announced that the appointment coincides with the naming of Mr. Pratt by trustees as president, general manager and trustee of the New England Alcohol Company, a Monsanto subsidiary at the Everett plant. Mr. Pratt has served as vice president and general sales manager of the New England Alcohol Company since 1942.

Assistant Division General Sales Manager Howard J. Heffernan, of Boston, was appointed division general sales manager to succeed Mr. Pratt, and Frederick S. Hatch, of Winchester, assistant to the division general manager, was elected by trustees as vice president of the New England Alcohol Company.

• Report on Coal Tar Imports

The United States Tariff Commission has issued a report on United States imports of coal-tar products in 1946. This report gives detailed statistics on coal-tar intermediates imported under paragraph 27 of the Tariff Act, and on dyes, medicinals and pharmaceuticals, flavor and perfume materials, and other finished products imported under paragraph 28.

According to the report, 1946 imports of coal-tar intermediates were twice as

large, in terms of value, as in 1945, but still far short of the prewar value. In quantity, imports in 1946 were 16 percent greater than prewar average. In 1946 imports totaled 3,120,564 pounds, valued at $437,169. Corresponding imports in 1945 amounted to 703,304 pounds, valued at $214,704, and for the prewar period 1937-39, averaged 2,692,805 pounds, valued at $2,380,963. The most important intermediates imported in 1946 were monomeric styrene from Canada; cresols and cresylic acid from Canada, Australia, and the United Kingdom; and naphthalene from Belgium and the Netherlands.

The value of imports of finished coal-tar products in 1946 was at about half the prewar level, and very much lower than in 1945, when imports of military explosives accounted for about two-thirds of the total. Imports of finished coal-tar products in 1946 amounted to 2,023,935 pounds, valued at $2,649,275, compared with the 1945 total of 27,565,752 pounds, valued at $4,877,103, and the prewar average (1937-39) of 4,207,145 pounds, valued at $5,631,205. In 1946 dyes constituted by far the most important group of imported finished products; they originated almost entirely in Switzerland and accounted for 2.4 million dollars, or 89 percent of the total value of all imports under paragraph 28.

The statistics given in the report were obtained by analyzing invoices covering imports through all United States customs districts.

Copies of the report may be obtained by writing to the United States Tariff Commission, Washington 25, D. C.

• New Calco Bulletin

A paper, "Studies of Wool Dyeing: Crocking", by H. E. Millson, W. H. Watkins and G. L. Royer, of the Calco Chemical Division, American Cyanamid Company, has been printed as a Calco Technical Bulletin for distribution to the textile industry.

The authors report the result of studies made of the relation between the intensity of the crock and incomplete scouring, the presence of dye solvents, hard water, drying, shearing, chlorination, Glauber's salt, temperature, pH and dye concentration. They point out the existence of a definite correlation between "the critical dyeing point" and "the critical crocking point." A wide range of dyes were used in making these studies and some of their observations recorded by photomicrographs of the cross sections are presented in a color plate.

Copies of Calco Technical Bulletin No. 780, may be obtained from your Calco representative, or by mailing your request to the Advertising Department, Calco Chemical Division, American Cyanamid Company, Bound Brook, New Jersey.

• Assistant Director of Research, Monsanto

Ivan V. Wilson has been appointed assistant director of research for the Monsanto Chemical Company's Merrimac Division, Josiah B. Rutter, general manager of the division, announced recently.

Mr. Wilson, who was manager of the Coating Sales Development Department prior to assumption of his present duties, will be in charge of all research and application work connected with the development of new and improved types of coatings. He will be responsible for maintaining close liaison with the division's sales department on such new coatings and will coordinate the activities of sales and production with research.

Mr. Wilson came to Monsanto in 1927 and since then has largely been connected with the Sales and Development Departments of the Merrimac Division. He is a native of Willow Springs, Kansas and a graduate of Kansas State College with a B.S. in Industrial Chemistry in 1924.

• Interchemical Textile Color Promotions

Interchemical Corporation, Textile Colors Division, Fair Lawn, N. J., manufacturer of Aridye Pigment Colors and Interchem Dyes has announced the election of Lawrence G. Meads as Division Chairman, and Norman S. Cassel as Divisional President. In addition to his duties with the Textile Colors Division, Mr. Meads will devote a substantial part of his attention to Interchemical's activities in the field of consumer products. Mr. Cassell, who formerly was vice-president and technical director, will be responsible for the general District Management of the Textile Colors Division. William B. DePass, formerly District Manager of the Southern District has been appointed Sales Manager of Aridye Pigment Colors and Clears. Fred Baumann is in charge of sales of Interchem Dyes.

• Joins Rumford Chemical

The appointment of Robert P. Beaven to the Technical Service staff is announced by Rumford Chemical Works, Rumford, Rhode Island.

During his five years in the Army, Beaven rose from private to captain, serving with the 63rd Infantry Division and spending twenty-two months in the European Theatre of Operations.

A graduate of Rhode Island State College with the degree of Bachelor of Science in Chemistry, Mr. Beaven also attended Worcester Academy and has received a special course of instruction at Lowell Textile Institute.

Mr. Beaven will handle technical service problems both in the laboratory and in the field in close cooperation with consumers and distributors.

• New Swift & Company Plant

Major engineering and equipment contracts for the industrial oil processing unit of Swift & Company's new Technical Products Plant in Hammond, Indiana, have been awarded, E. A. Moss, vice president, announced recently in reporting progress of the project.

The industrial oil unit will be constructed on part of a 70-acre site owned by the company on Indianapolis Boulevard at 165th Street. It is expected to be completed in 1948.

This initial unit will process special oils for use in the manufacture of rubber, textiles, soap, cosmetics, linoleum, paint, lubricants and many other industrial products.

• Carbide and Carbon Research at Mellon

Announcement has just been made of the establishment at Mellon Institute, Pittsburgh, of a new research group to study industrial applications of vapor-absorbent activated carbon. This group is part of a fellowship sponsored by Carbide and Carbon Chemicals Corporation. It will co-operate with users of vapor adsorbent carbons to improve equipment and processes for the recovery of solvent vapors, to study methods for the purification of industrial gases and deodorization of air, and to study industrial processes for the separation of materials in the vapor phase.

To aid these studies, a versatile, new experimental pilot plant for solvent recovery with activated carbon has now been installed. Automatically controlled, this new pilot plant replaces a manually-operated unit, and can duplicate accurately the conditions in industrial solvent recovery plants using "Columbia" activated carbon. Engineering data thus obtained make possible design improvements for new plants and operating economies for plants now being run.

This new pilot plant is part of equipment being used in an ever-growing research program, which is continuously improving solvent recovery carbons and processes. "Columbia" activated carbon

in plants already installed and under construction has a normal yearly recovery capacity of over 1,250,000,000 pounds of solvent having a value of about 100 million dollars.

• Arctic Syntex "M" Available

Increased production facilities have made it possible for the Colgate-Palmolive-Peet Company of Jersey City, New Jersey, to reinstate Arctic Syntex 'M' Beads, modern development in soapless detergents, to its industrial list. It is now available in 90-pound barrels.

Unavailable during the war because most of the output went to various branches of the armed forces for specialized uses, Arctic Syntex 'M' is claimed to bring quicker, more efficient cleaning action not only in wool and fine fabric laundering, but also to the washing of glassware and dishes by hand, rug washing, auto washing, textile processing, and many other cleaning, laundering and processing operations. It is recommended by the manufacturers for use wherever a detergent stable in hard water, mild acid and neutral in reaction is called for.

• Nopco Sales Representative

The appointment of George E. Motz as a sales representative for the Industrial Division of Nopco Chemical Company, Harrison, N. J., was recently announced by Thomas A. Printon, vice-president.

Mr. Motz is a graduate of Pennsylvania State College and served seven years with the Army of the United States. For action with the Chemical Warfare Service in the ETO he was awarded five battle stars, the Bronze Star and the Belgian Fourragere. At the time of his release to inactive duty he held the rank of Lt. Colonel.

For the past 14 months, Mr. Motz has been associated with the company at its Cedartown, Ga., plant. The territory to be covered by him includes the state of Alabama, Mississippi, Louisiana, Western Tennessee and Arkansas, where he will service the accounts of both Nopco and its subsidiary, Metasap Chemical Company.

• Booklet on Paterson

The Industrial Commission of Paterson, N. J., has just issued a 28-page industrial guidebook entitled, "Paterson the Strategic City." The publication states that Paterson has become and remains one of the great manufacturing centers which make this nation the industrial leader of the world. It goes on to relate how, because of the city's long industrial history, there has been an opportunity to cultivate basic understanding between labor aned managment. It stresses Paterson's proximity to the great New York market, its facilities for general distribution and its closeness to suppliers.

A number of pages are devoted to Paterson's production facilities and to the products which it manufactures. It emphasizes that Paterson is noted for both the variety and quality of its industrial products, ranging from textiles to precision equipment. All told, several hundred different products are manufactured in the city.

Copies of "Paterson the Strategic City" will be sent promptly by the Industrial Commission, Paterson, N. J.

• Joins E. F. Houghton

Dr. H. B. Walker, formerly Director of Textile Research for Rohm & Haas Company, Philadelphia, Pa. who has been appointed Assistant to Dr. R. H. Patch, Vice-President in charge of Operations, E. F. Houghton & Co., oil, leather and chemical manufacturers, Philadelphia.

Prior to being placed in charge of Textile Research with Rohm & Haas, Dr. Walker was Manager of its Leather Finishes Department, and since the beginning of 1946 had charge of development of Textile Chemicals and Leather Finishes, as well as being Research Supervisor in charge of the Physico-chemical and Physics Laboratories.

Dr. Walker has been an active member of the AATCC for several years, and has served on the Detergency Committee of the Association.

His duties with E. F. Houghton & Co. include product and process development and application research. He will serve as a liaison between Research, Engineering, Manufacturing and Sales Departments.

• General Releases

General Dyestuff Corp., 435 Hudson Street, New York 14, N. Y., has announced the release of circulars describing the following products:

Fast Scarlet Salt G—the diazotized and stabilized Fast Scarlet G Base. It is soluble in water and couples directly with Naphtolates to form insoluble Naphtol colors. It yields principally scarlet shades with most Naphtols. On grounds prepared with Naphtols AS-LB and AS-DB, brown shades are obtained. The most useful combinations are said to possess very good fastness to washing, good fastness to light, chlorine and hot pressing, and fairly good fastness to crocking. It is sufficiently soluble to be applicable in all types of dyeing equipment and the method of development depends upon the Naphtol being used and the equipment available. When printed on Naphtol AS prepare, it produces a bright scarlet said to possess very good fastness properties. Dyeings of this combination are dischargeable to a clear white if anthraquinone is used in the discharge paste.—*Circular G-470.*

*Peregal OK**—a new quaternary ammonium compound recommended by the manufacturers as a retarding, leveling and stripping agent primarily for vat dyestuffs. It is said to promote level dyeing and improve penetration due to its retarding action on vat dyes particularly when dyeing light shades. It is a cationic substance and entirely different chemically to Peregal O, which is non-ionogenic. Peregal OK is satisfactory to use with Indanthrene Blues and Indigoid dyestuffs.—*Circular G-475.*

Indanthrene Printing Violet 4RN Extra Paste—the printing modification of the vat dye Indanthrene Brilliant Violet 4R. It is stated that it is specially standardized for printing, finely dispersed, of medium consistency and free from grit. It fixes well on cotton and rayon. It produces fairly bright shades said to possess very good fastness to light, chlorine and washing.—*Circular G-477.*

Celfon—for permanent finishing of fabrics. Advantages claimed for this product are: it is not removed during many commercial launderings at high temperature or any type of dry cleaning; it can increase the tensile strength approximately 10% and the resistance to abrasion over 20%; it reduces residual shrinkage, to obtain better wash widths, and increase yardage yields, from greige to Sanforize; it will reduce yarn slippage on low count fabrics and increase luster and body of all fabrics. *Celfon H* is said to be suitable for the production of the firmer and full-bodied wash-fast finishes; *Celfon*

* Patented.

M is more suitable for a range of cotton fabrics where some fullness is desired with just a trace of firmness required to produce the effect of newness; *Celfon L* is said to show promise in the rayon finishing field. The circular gives further information on the types available, the making of Celfon solutions, and application procedures.

Celfon also may be used in conjunction with vat and Algosol dyestuffs on washable rayons. The resultant finished fabrics are said to have a full hand, excellent dye penetration and improved resistance to slippage on low count constructions. It is further stated that Celfon stabilizes the fabric, reducing the residual shrinkage in most cases to practical tolerance when properly handled.—*Circular GDC-258.*

• Meeting, Textile School Deans

The ten textile schools in the United States now have an enrollment of over 2700 full time day students working for degrees or certificates in textile engineering, manufacturing, or some other branch of activity related to the textile industries. In addition there are over 2000 evening students and about 50 more doing work at the graduate level. Of these students the different schools report 75 to 90 per cent G.I.'s. As seems to be the case in colleges throughout the country, this class of students is reported by the schools as being exceptionally diligent and serious in their efforts to obtain all they can out of the educational facilities provided.

This information was collected at the spring meeting of the National Council of Textile School Deans just held at Atlantic City, New Jersey. All sessions of the conference were devoted to a discussion of school problems and procedures especially those complex ones arising from the unusually heavy registration and teaching schedules. Other subjects discussed were the outlook for fall enrollments, policies related to out of state and foreign students, the securing of new equipment and machinery for teaching purposes, improvement in course of curricula content, visual education aids, research activities in the schools, the training of suitable candidates for teaching jobs, and the securing of qualified instructors.

Dr. John H. Dillon, Director of Scientific Research for the Textile Foundation, described the research activities being conducted at the Laboratory in Princeton. He also outlined a plan under which certain graduates of textile schools could engage in part time work in the Princeton Laboratories while taking qualifying courses in the undergraduate school with the idea of qualifying for entrance into Princeton University's Graduate School as a Research Fellow of the Textile Research Institute. Present at the conference were Hugh M. Brown, Dean, Clemson College Textile School, Releigh, N. C.; Malcolm E. Campbell, Dean, N. C. State College Textile School, Raleigh, N. C.; Donald Comer, Avondale Mills, Birmingham, Ala., Director, Textile Foundation; Leslie B. Coombs, Dean, Bradford Durfee Textile School, Fall River, Mass.; Richard S. Cox, Dean, Philadelphia Textile Institute, Inc., Philadelphia, Penna.; Herman A. Dickert, Dean, A. French Textile School, Georgia School of Technology, Atlanta, Ga.; Charles H. Eames, Lowell Textile Institute, Lowell, Mass.; W. D. Fales, Head, Textile School, Rhode Island School of Design, Providence, R. I.; Dr. F. M. Feiker, Dean, School of Engineering, The George Washington University, Washington, D. C., Textile Foundation Consultant on Textile Education; Kenneth R. Fox, President, Lowell Textile Institute, Lowell, Mass.; Franklin W. Hobbs, Box 200—Essex Station, Boston, Mass., Chairman, Board of Directors, Textile Foundation; C. A. Jones, A. French Textile School, Georgia School of Technology, Atlanta, Ga.; Dr. Thomas Nelson, Dean Emeritus, N. C. State College Textile School, Raleigh, N. C.; L. E. Parsons, Head, Textile Engineering Dept., Texas Technological College, Lubbock, Texas; Edward T. Pickard, Secretary, The Textile Foundation, Washington, D. C.; George Walker, Dean, New Bedford Textile School, New Bedford, Mass.

• Fiberglas Yarns Dyed By New Process

Development of a new process of filament coating, whereby a thin protein film (gelatin type) is applied to Fiberglas yarns as they are formed, has made it possible to dye the yarns with ordinary dyes and by commonly used methods.

Dyed Fiberglas yarns are available for drapery materials and other decorative applications in the following colors: wine, gold, silver, two shades of yellow, coral pink, three shades of green, blue, brown and grey. A large industrial use of the dyed yarns is as identification yarns in electric wires and cables. Colors available for this application are blue, orange, green, yellow, black, brown, slate red and purple.

The protein film that is applied to the filaments while the yarn is being formed represents only one to two per cent, by weight, of the finished yarn, but with this small amount of film, improved depth of color has been achieved, due to absorption of the dyes by the film on the large surface area presented by the multiple-filament yarn.

Soluble vat dyes are the most resistant to fading and washing. Direct dyes, acid dyes and chromes give the deepest shades. Resin after-treatment is used to reduce crocking, when necessary. Dyeing takes place rapidly, chiefly because of the large surface area and because the dyes do not penetrate the fibers. The yarns do not shrink or swell during the dyeing process. When used in woven fabrics, in combination with other yarns, the Fiberglas yarns help prevent stretching during the finishing process.

Dyed Fiberglas yarns for decorative uses have a minimum of 80 hours sunfastness and can be dry cleaned.

• Price Reductions Announced

Sizeable price reductions on a complete array of synthetic organic detergents, Mercol ST Bead and 85-87% Active Flakes were announced this month by Seaboard Distributors, Inc., 60 Park Place, Newark, N. J.

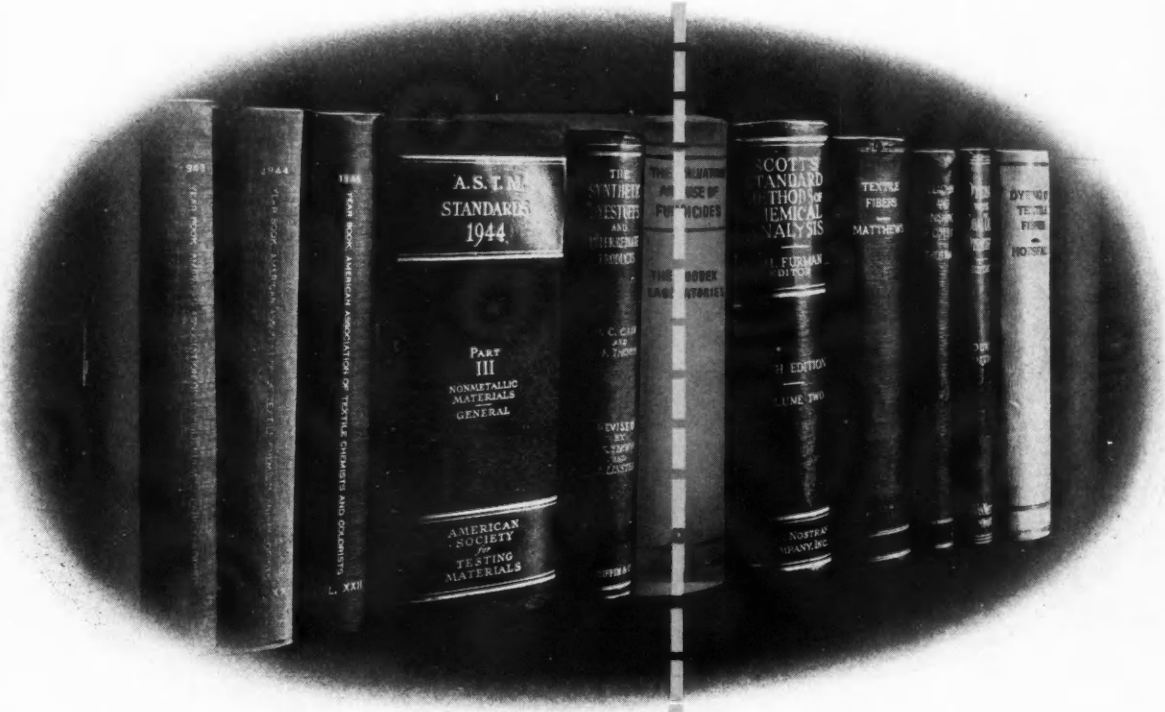
The New Jersey sales organization, which is headquarters for all types of textile chemicals, textile soaps, tallow soaps for industry and industrial surface active agents, also announces the addition of a new Bubble Bath Base to the list of Seaboard products. The new Bubble Bath Base has high foaming characteristics and finer foam stability.

• Annual Meeting, National Federation of Textiles

Henry Neubert, vice president of Deering Milliken & Company, Inc., was elected to the Presidency of The National Federation of Textiles, Inc., at the seventy-fourth annual meeting. The Federation re-elected its present Board of Directors except for replacing Paul Whitin, at his request, with Benjamin E. Marks, a director of the Paul Whitin Mfg. Company, and New York sales agent for the Company. An innovation this year was the election of three, instead of one, vice presidents. The new officers are John Fox of Fox, Wells & Company, Inc., selling agents for the Dover, Esther and Ora Mills; Alexander F. Ix, President of Frank Ix & Sons, Inc.; and C. C. Griffith, Vice President of the Newmarket Mfg. Company. Irene Blunt was re-elected Secretary and Treasurer.

• Lecture on Detergents

Dr. Cornelia T. Snell of Foster D. Snell, Inc., 29 West 15th Street, New York City, Consulting Chemists and Engineers, gave the annual Marie Curie lecture at Pennsylvania State College on May 5th. Her subject was "Synthetic Detergents and Surface Activity." This lecture is sponsored by the local chapter of Iota Sigma Pi, Women's National Honorary Chemical Society.



THIS MANUAL ISN'T ON YOUR REFERENCE SHELF—YET!

WE WISH it could have been a surprise gift to the AATCC on its Silver Anniversary—an authoritative, modern work on fungicides by the Nuodex Laboratories, "The Evaluation and Use of Fungicides". We've got the facts for such a manual—files of them—based on thousands of man-hours of thorough, untiring research and extensive laboratory and field tests. But the expansion of our line of Nuodex fungicides to assure you of practical mildew control has taken so much of our time that the preparation of the manual has been delayed.

Until it is ready for publication, we'll gladly dig into our files for any information you want on the subject. Or if you're interested in a practical fungicide for your own use—to add the sales plus of mildewproofness to your product or stop mildew in your processing—chances are we can supply or develop the material you're looking for. May we help you—today?

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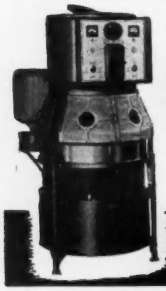
Faithfully duplicates the combined weathering effects of sunlight, rain, and heavy dew; accelerated to reduce years of actual weathering to a few days' testing. All weather cycles automatically controlled for continuous operation without attention.



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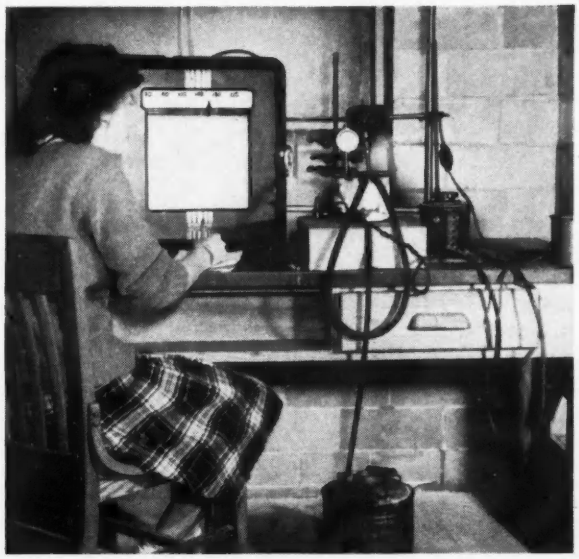

Data Are Recorded Ultra-*Promptly* With *Speedomax* Instruments

Because speed of measurement is all-important in testing their thermostats, Vernay Laboratories, Inc., has assembled the Speedomax Recorder and other equipment shown above to provide an automatic record, both of temperature and of temperature change. Similar equipment can of course be used in many other test operations.

The bowl at the right of the Speedomax, and in the photo at right, holds the Vernatherm power thermostat which is being tested, and the water for heating the 'stat. The thermocouple detects water temperature for the Speedomax.

After using the equipment, Vernay engineers say that Speedomax gives the test the following characteristics:

1. Overall speed of measurement is "several times" greater than with any other method used. Record is automatic.
2. Temperature range can be as wide as desired.
3. Record shows many fluctuations which manual charts miss.
4. Minimum technical skill is required to run the tests.

Speedomax Type G Recorder is described in Catalog ND46(1), sent on request. If you have a specific problem, send the necessary data and an L&N engineer will write or call, as you prefer.

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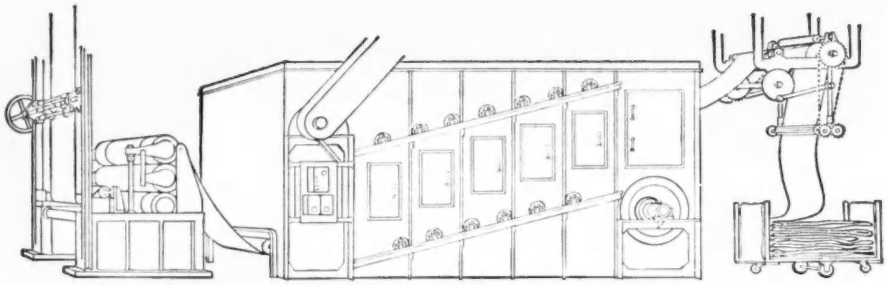
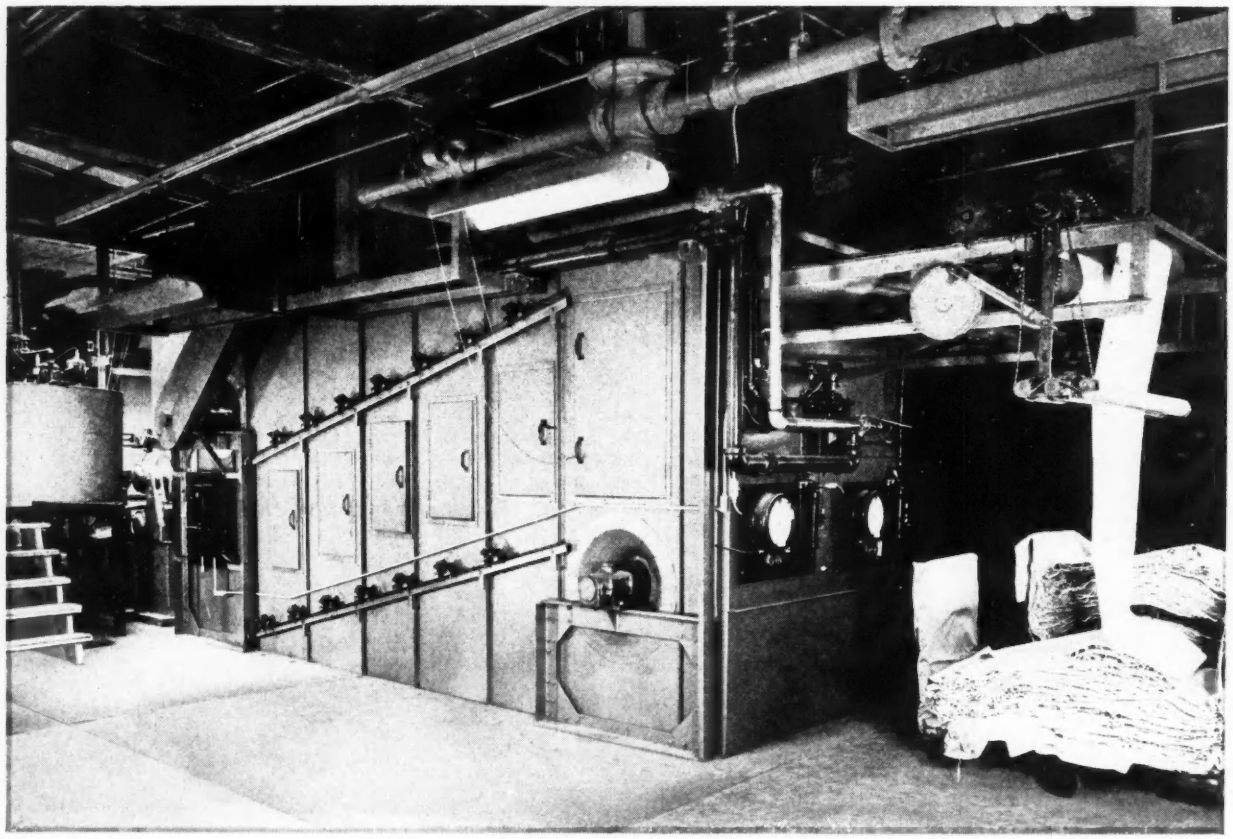
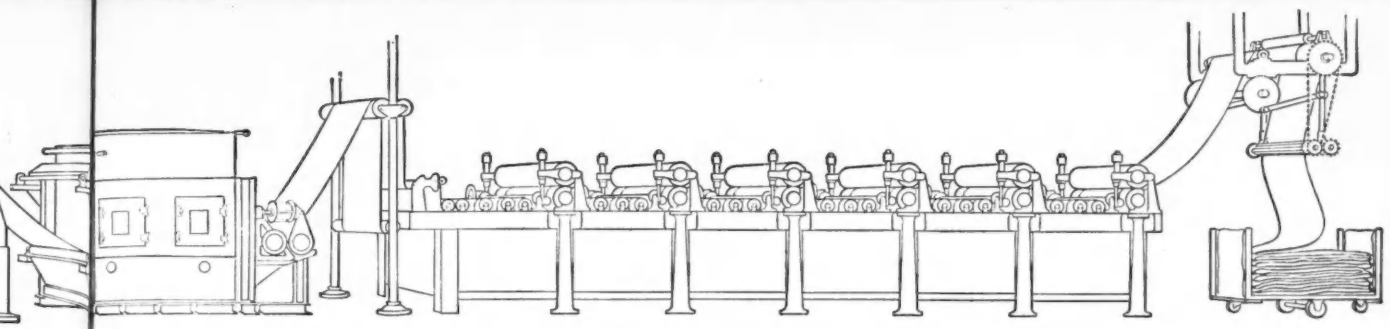


In the first section of the Butterworth Vat Dyeing Range, goods enter a 3-roll padder in which the color is applied in pigment form, followed by drying on a special type air-dryer and folding onto a hand truck.



Delivery end of Butterworth 2-roll pad and impinge dryer in Vat Dyeing Range. Accurate control of the air velocity and temperature in the impinge dryer eliminates any possibility of migration. Goods are dried to within 15-20% of the moisture content.



In the second section of the Butterworth Vat Dyeing Range, goods are impregnated with chemicals on a 3-roll padder and then enter a steamer. (Note choice of cloth entrance—at top for straight steam process or at bottom through a liquid seal for steam and liquid booster processes.) After steaming, goods pass through a water seal and squeeze rolls, and are washed in a 6-box washer, followed by folding onto hand truck.

FINER, FASTER COLORS AT LOWER COST TO YOU

A full range of vat colors, from pastel to very deep shades, can be applied continuously on the Butterworth Vat Dyeing Range. Improved appearance, greater color yield, fastness to crocking, washing and bleaching, as well as fastness to light are imparted to a wide variety of fabrics in either long or short yardages.

There are substantial savings, up to 25% in the cost of color application. Exhaustion problems are overcome. Seconds due to shade variations and specking are eliminated. Close shade control is obtained even in short runs. Liquid boosters can be added to meet specific mill conditions.

The Butterworth Continuous Vat Dyeing Range is designed to allow easy access for threading. Tensions are adjustable for various fabrics. Non-oxidizing metal is used exclusively in the construction.

The Butterworth Continuous Vat Dyeing Range operates at speeds up to 120 yards per minute for increased production. The controlled action of liberated "live" steam permits these speeds without effecting the chemical stability of the leuco.

Investigate the Butterworth Continuous Vat Dyeing Range. Write or call for detailed information.

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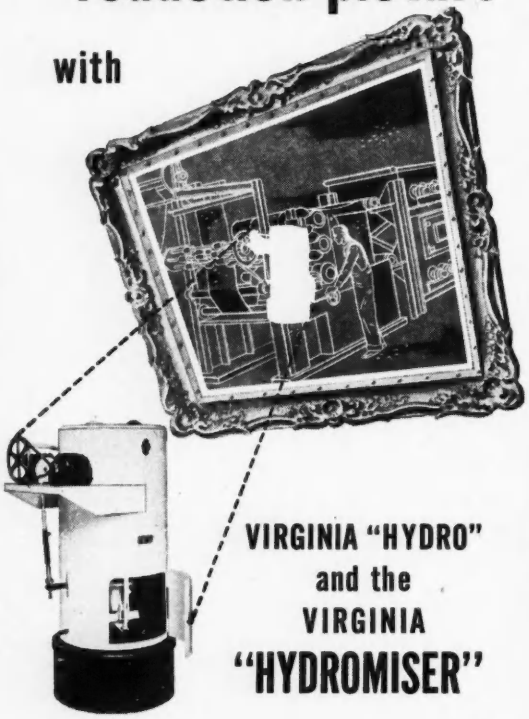

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The Hydromiser—exclusive with "Virginia"—was developed to feed "Virginia" Sodium Hydrosulphite *automatically* into the dyebath. It insures uniformity through accurately controlled flow . . . one pound to 200 pounds per hour. Cost-conscious finishers report 10 to 15 per cent savings in $Na_2S_2O_4$ and a marked reduction of rejects in continuous dye operation. If your dye operation is continuous, you should get full information about the Hydromiser. VIRGINIA SMELTING COMPANY, West Norfolk, Virginia. *Established 1898.*

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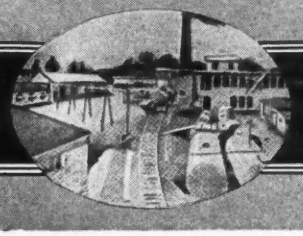

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The Fleet Line Stock Dye Kettle has become practically standard equipment for the dyeing of raw wool of all types as well as rags and clips. It is also widely used for the dyeing of all types of rayon, both staple and filament, as well as cotton. Advantages are as follows:-

1. Stock undisturbed in kettle. Comes out in open, lofty condition.
2. Complete and uniform penetration of dye liquor.
3. Stock unloaded in cake form on false bottom, by electric or air hoist.
4. Temperature, pressure and depth indicators.
5. Safety sampling cover. Will not open when machine is in operation.
6. Unit construction keeps outside pipes and fittings to minimum.
7. Vertical pump requires no packing.
8. Vertical motor on top of machine away from water and dirt.

Most of these features are EXCLUSIVE with Riggs & Lombard and are protected by Patents Nos. 2410214, 2275818 and 1813784, registered at the U. S. Patent Office.

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WANTED: SALESMAN. Excellent opportunity for the right man with leading chemical manufacturer for New England territory. Must have selling experience and personal contacts and preferably chemical or textile mill background. Write complete details to Box 218.

POSITION WANTED: Textile Colorist with several years of experience in the Screen Printing field. All types of materials. Metropolitan area preferred. Write Box 238.

POSITION WANTED: Chemist, capable assuming full responsibility, diversified practical experience dyeing and printing, seeks connection with vigorous expanding organization. Write Box 237.

WANTED: Man 25-30 years old, to represent large textile chemical manufacturer in South. Textile School or Technical School education, and two or three years finishing plant experience required. Exceptional opportunity for right man. Write Box 233.

POSITION WANTED: Graduate of Lowell Textile Institute with a bachelor of textile chemistry degree. Three years experience in using all types of dyes applying same to the various fibers and plastics. Interested in research and development among these lines. At present assistant head of laboratory, age 25, married. Write Box 243.

WANTED: Chemist—Chicago Area, Textile Coating experience. Give training, age, experience, salary. Write Box 232.

WANTED: Chemist. Progressive Dye and Print Plant in Metropolitan Area wants chemist with experience in dyeing, printing and finishing. Excellent opportunity for right man. All applications confidential. Write Box 244.

WANTED: DYESTUFFS MAN WITH EXPORT EXPERIENCE — FIRST-CLASS FIRM — NEW YORK CITY. Write Box 245.

WANTED: Assistant Supt. Dyeing and Print Works. We expect the successful applicant to have substantial experience in either dyeing or printing and in handling of help. Give full history in first letter. Write Box 246.

WANTED: Sales Manager, textile chemicals and soaps; must be fully experienced to take charge of newly organized Textile Chemical Dept. with old established firm. Excellent opportunity. Write Box 247.

WANTED: 1100 LBS. RHODAMINE 500%; up to 10 TONS BETA-NAPTHOL. Write Box 248.

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TEXODORS will meet your most stringent requirements for tenacity of dyes, heat resistance, color neutrality, low cost and economical application. Write *now* for full information, samples and prices.

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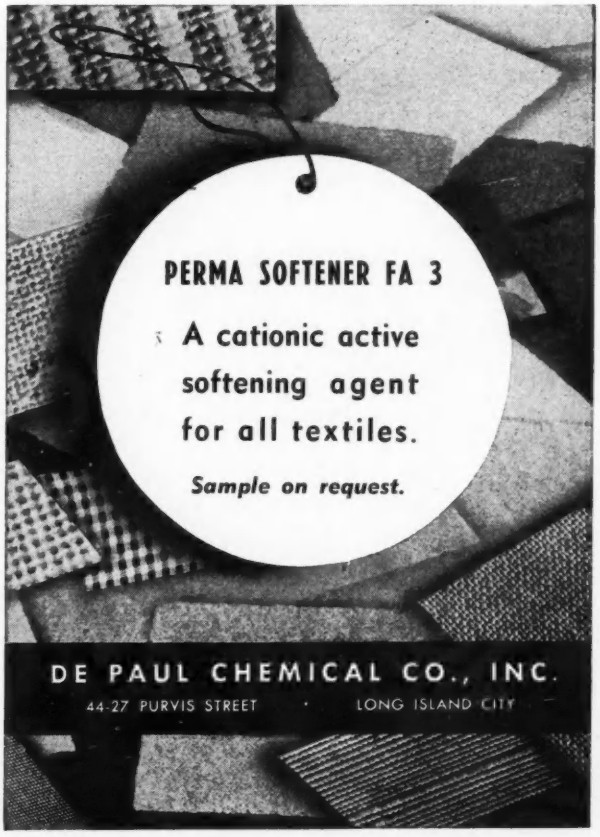
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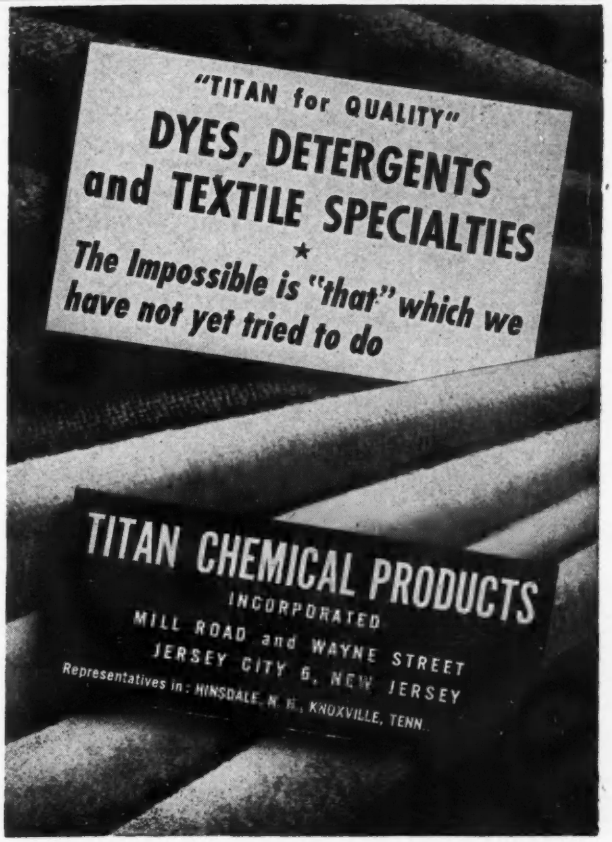
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One Madison Avenue New York 10, N. Y.

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POLYVINYL ACETATES

DAREX COPOLYMER X 52-L
Low molecular weight polyvinyl acetate emulsion. Requires about one third less plasticizer than high molecular weight resin for most applications. Total solids: 52-55%.

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High molecular weight polyvinyl acetate emulsion. Total solids: 53-55%.

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Modified high molecular weight polyvinyl acetate emulsion adjusted to higher emulsion viscosity than X 56-L.

HIGH STYRENE RESINS

DAREX COPOLYMER NO. 3-L
Stabilized latex form of DAREX Copolymer No. 3, a 70 Styrene/30 Butadiene rubber resin. Film former and reinforcing agent. May be used either cured or uncured. Total solids: 45-47% pH 8-10.

DAREX COPOLYMER NO. X 34-L
Stabilized latex form of DAREX Copolymer No. X 34, an 85 Styrene/15 Butadiene rubber resin. Reinforcing agent for use to obtain harder, tougher films. Total solids: 45-47% pH 8-10.

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Artistry in Chemistry

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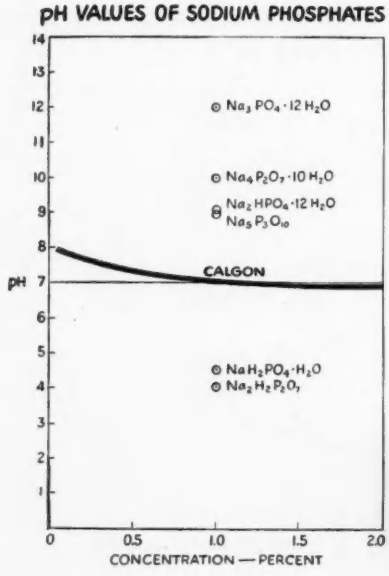

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